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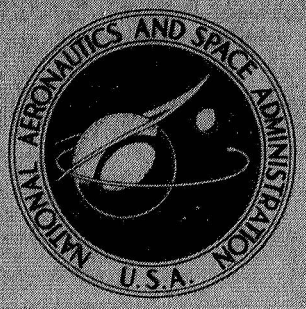

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USER'S MANUAL FOR A DIGITAL COMPUTER PROGRAM FOR COMPUTING THE VIBRATION CHARACTERISTICS OF RING-STIFFENED ORTHOTROPIC SHELLS OF REVOLUTION

by Howard M. Adelman, Donnell S. Catherines, Earl C. Steeves, and William C. Walton, Jr.

Langley Research Center
Hampton, Va. 23365

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ERRATA

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December 1970

Page 13: The last 8 lines should read as follows:

IPLOT controls the CALCOMP plotting of the mode shapes and modal stresses.
If IPLOT is set equal to zero neither mode shapes nor modal stresses are plotted.
If IPLOT is nonzero all the calculated mode shapes are plotted.

IPLSTS controls the CALCOMP plotting of the modal stresses.
If IPLSTS is set equal to zero modal stresses are not plotted.
If IPLSTS is nonzero all the calculated stresses are plotted.

Page 28: In figure 5, the dimension in the detail of rings 2 and 3 which is indicated as 1.18 should be 1.13.

Pages 94 and 95: Table X on page 94 and Table XI on page 95 should be replaced by the enclosed corrected Tables X and XI.

NASA-Langley, 1971 -

Issued October 1971

TABLE X.- ELEMENTS OF MATRIX $[A_k]$

$$
\begin{bmatrix}
1 & -\frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & -\frac{\epsilon_k^3}{8} & \frac{\epsilon_k^4}{16} & -\frac{\epsilon_k^5}{32} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & -\frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & -\frac{\epsilon_k^3}{8} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -\frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & -\frac{\epsilon_k^3}{8} \\
0 & 1 & -\epsilon_k & \frac{3\epsilon_k^2}{4} & -\frac{\epsilon_k^3}{2} & \frac{5\epsilon_k^4}{16} & -\frac{1}{R_{1,k}} & \frac{\epsilon_k}{2R_{1,k}} & -\frac{\epsilon_k^2}{4R_{1,k}} & \frac{\epsilon_k^3}{8R_{1,k}} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -\epsilon_k & \frac{3\epsilon_k^2}{4} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -\epsilon_k & \frac{3\epsilon_k^2}{4} \\
0 & 0 & 2 & -3\epsilon_k & 3\epsilon_k^2 & -\frac{5\epsilon_k^3}{2} & \frac{R'_{1,k}}{R_{1,k}^2} & -\frac{1}{R_{1,k}}\left(\frac{\epsilon_k R'_{1,k}}{2R_{1,k}} + 1\right) & \frac{\epsilon_k}{R_{1,k}}\left(\frac{\epsilon_k R'_{1,k}}{4R_{1,k}} + 1\right) & -\frac{\epsilon_k^2}{4R_{1,k}}\left(\frac{\epsilon_k R'_{1,k}}{2R_{1,k}} + 3\right) & 0 & 0 & 0 & 0 \\
1 & \frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & \frac{\epsilon_k^3}{8} & \frac{\epsilon_k^4}{16} & \frac{\epsilon_k^5}{32} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & \frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & \frac{\epsilon_k^3}{8} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & \frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & \frac{\epsilon_k^3}{8} \\
0 & 1 & \epsilon_k & \frac{3\epsilon_k^2}{4} & \frac{\epsilon_k^3}{2} & \frac{5\epsilon_k^4}{16} & -\frac{1}{R_{1,k+1}} & -\frac{\epsilon_k}{2R_{1,k+1}} & -\frac{\epsilon_k^2}{4R_{1,k+1}} & -\frac{\epsilon_k^3}{8R_{1,k+1}} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & \epsilon_k & \frac{3\epsilon_k^2}{4} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & \epsilon_k & \frac{3\epsilon_k^2}{4} \\
0 & 0 & 2 & 3\epsilon_k & 3\epsilon_k^2 & \frac{5\epsilon_k^3}{2} & \frac{R'_{1,k+1}}{R_{1,k+1}^2} & \frac{1}{R_{1,k+1}}\left(\frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}} - 1\right) & \frac{\epsilon_k}{R_{1,k+1}}\left(\frac{\epsilon_k R'_{1,k+1}}{4R_{1,k+1}} - 1\right) & \frac{\epsilon_k^2}{4R_{1,k+1}}\left(\frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}} - 3\right) & 0 & 0 & 0 & 0
\end{bmatrix}
$$

TABLE XI.- ELEMENTS OF MATRIX $[T_k]$

$$
\begin{bmatrix}
\frac{1}{2} & \frac{\epsilon_k}{32R_{1,k}}\left(5 - \frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & \frac{5\epsilon_k}{32} & \frac{\epsilon_k^2}{64R_{1,k}} & 0 & \frac{\epsilon_k^2}{64} & \frac{1}{2} & -\frac{\epsilon_k}{32R_{1,k+1}}\left(5 + \frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & -\frac{5\epsilon_k}{32} & \frac{\epsilon_k^2}{64R_{1,k+1}} & 0 & \frac{\epsilon_k^2}{64} \\
-\frac{15}{8\epsilon_k} & \frac{1}{16R_{1,k}}\left(-7 + \frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & -\frac{7}{16} & -\frac{\epsilon_k}{32R_{1,k}} & 0 & -\frac{\epsilon_k}{32} & \frac{15}{8\epsilon_k} & -\frac{1}{16R_{1,k+1}}\left(7 + \frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & -\frac{7}{16} & \frac{\epsilon_k}{32R_{1,k+1}} & 0 & \frac{\epsilon_k}{32} \\
0 & \frac{1}{4\epsilon_k R_{1,k}}\left(-3 + \frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & -\frac{3}{4\epsilon_k} & -\frac{1}{8R_{1,k}} & 0 & -\frac{1}{8} & 0 & \frac{1}{4\epsilon_k R_{1,k+1}}\left(3 + \frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & \frac{3}{4\epsilon_k} & -\frac{1}{8R_{1,k+1}} & 0 & -\frac{1}{8} \\
\frac{5}{\epsilon_k^3} & \frac{1}{2\epsilon_k^2 R_{1,k}}\left(5 - \frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & \frac{5}{2\epsilon_k^2} & \frac{1}{4\epsilon_k R_{1,k}} & 0 & \frac{1}{4\epsilon_k} & -\frac{5}{\epsilon_k^3} & \frac{1}{2\epsilon_k^2 R_{1,k+1}}\left(5 + \frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & \frac{5}{2\epsilon_k^2} & -\frac{1}{4\epsilon_k R_{1,k+1}} & 0 & -\frac{1}{4\epsilon_k} \\
0 & \frac{1}{2\epsilon_k^3 R_{1,k}}\left(1 - \frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & \frac{1}{2\epsilon_k^3} & \frac{1}{4\epsilon_k^2 R_{1,k}} & 0 & \frac{1}{4\epsilon_k^2} & 0 & -\frac{1}{2\epsilon_k^3 R_{1,k+1}}\left(1 + \frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & -\frac{1}{2\epsilon_k^3} & \frac{1}{4\epsilon_k^2 R_{1,k+1}} & 0 & \frac{1}{4\epsilon_k^2} \\
-\frac{6}{\epsilon_k^5} & \frac{1}{\epsilon_k^4 R_{1,k}}\left(-3 + \frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & -\frac{3}{\epsilon_k^4} & -\frac{1}{2\epsilon_k^3 R_{1,k}} & 0 & -\frac{1}{2\epsilon_k^3} & \frac{6}{\epsilon_k^5} & -\frac{1}{\epsilon_k^4 R_{1,k+1}}\left(3 + \frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & -\frac{3}{\epsilon_k^4} & \frac{1}{2\epsilon_k^3 R_{1,k+1}} & 0 & \frac{1}{2\epsilon_k^3} \\
0 & \frac{1}{2} & 0 & 0 & \frac{\epsilon_k}{8} & 0 & 0 & 0 & \frac{1}{2} & 0 & 0 & -\frac{\epsilon_k}{8} & 0 & 0 \\
0 & -\frac{3}{2\epsilon_k} & 0 & 0 & -\frac{1}{4} & 0 & 0 & 0 & \frac{3}{2\epsilon_k} & 0 & 0 & -\frac{1}{4} & 0 & 0 \\
0 & 0 & 0 & 0 & -\frac{1}{2\epsilon_k} & 0 & 0 & 0 & 0 & 0 & 0 & \frac{1}{2\epsilon_k} & 0 & 0 \\
0 & \frac{2}{\epsilon_k^3} & 0 & 0 & \frac{1}{\epsilon_k^2} & 0 & 0 & 0 & -\frac{2}{\epsilon_k^3} & 0 & 0 & \frac{1}{\epsilon_k^2} & 0 & 0 \\
0 & 0 & \frac{1}{2} & 0 & 0 & \frac{\epsilon_k}{8} & 0 & 0 & 0 & \frac{1}{2} & 0 & 0 & -\frac{\epsilon_k}{8} & 0 \\
0 & 0 & -\frac{3}{2\epsilon_k} & 0 & 0 & -\frac{1}{4} & 0 & 0 & 0 & \frac{3}{2\epsilon_k} & 0 & 0 & -\frac{1}{4} & 0 \\
0 & 0 & 0 & 0 & 0 & -\frac{1}{2\epsilon_k} & 0 & 0 & 0 & 0 & 0 & 0 & \frac{1}{2\epsilon_k} & 0 \\
0 & 0 & \frac{2}{\epsilon_k^3} & 0 & 0 & \frac{1}{\epsilon_k^2} & 0 & 0 & 0 & -\frac{2}{\epsilon_k^3} & 0 & 0 & \frac{1}{\epsilon_k^2} & 0
\end{bmatrix}
$$

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15. Supplementary Notes

16. Abstract

Detailed information is given on the use of a digital computer program for the calculation of the vibration characteristics of orthotropic shells of revolution with and without ring stiffeners. This information includes input parameter definition and coding format, computing options available to the user, and output definition. Application of the program is illustrated by two sample calculations.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
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CONTENTS

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SUMMARY

The use of a digital computer program for computing the vibration characteristics of orthotropic thin shells of revolution with or without ring stiffeners is described. The program is based on the finite-element method and is applicable to shells having general meridional curvature.

Detailed instructions in the use of the program are included in the report as are explanations of the various computing options available to the user. Among these options are computation of natural frequencies, mode shapes, modal stresses and strains, and stress resultants.

Use of the computer program is illustrated by calculation of vibration characteristics of two typical shell configurations: an unstiffened cylindrical shell and a ring-stiffened conical frustum.

INTRODUCTION

A procedure based on the finite-element method for the computation of vibration characteristics of orthotropic shells of revolution is described in reference 1. That reference contains the theoretical developments and the basic computational steps of the procedure but does not contain sufficient user information to serve as a user's manual for the computer program. In addition, several improvements in and additions to the procedure have been made by the authors since the publication of reference 1. The purpose of this report is to serve as a user's manual for the improved version of the computer program and also to present the theoretical basis for the changes in the procedure since the publication of reference 1.

The body of the report consists of the user's manual. The improvements in the computer program are described in the appendixes. The improvements and additions are as follows:

(1) The use of a more sophisticated approximation to the displacement field within each element has been implemented. This improvement is described in appendix A.

(2) The capability of the procedure has been extended to include the calculation of modal stresses and strains. This addition is described in appendix B.

(3) The capability to include the effects of ring stiffeners has been added to the program. This addition is described in appendix C.

Because the basic developments of the computer program are contained in reference 1 the present report places great reliance on this reference, and it is essential that reference 1 be used in conjunction with the present report. The present report is in other respects self-contained.

SYMBOLS

A cross-sectional area of ring

A_k matrix which relates displacements and rotations at ends of an element to coefficients of polynomial displacement functions

a distance from axis of shell to origin of ξ_1, ξ_3 axes (see fig. 7)

$a_{0,k}, a_{1,k}, a_{2,k}, a_{3,k}, a_{4,k}, a_{5,k}$ coefficients in polynomial displacement functions for w

$b_{0,k}, b_{1,k}, b_{2,k}, b_{3,k}$ coefficients in polynomial displacement function for u

C_{11}, C_{12}, C_{22} membrane stiffness parameters

C_{66} shear stiffness

$c_{0,k}, c_{1,k}, c_{2,k}, c_{3,k}$ coefficients in polynomial displacement function for v

D_{11}, D_{12}, D_{22} flexural stiffness parameters

D_{66} torsional stiffness

E Young's modulus for ring

EA extensional stiffness of ring

E_1 Young's modulus in meridional direction

E_2 Young's modulus in circumferential direction

EI_1 bending stiffness of ring about ξ_1-axis

EI_3 bending stiffness of ring about ξ_3-axis

EI_{13} bending stiffness of ring due to coupling between bending about ξ_1- and ξ_3-axes

$E\Gamma_1$ stiffness of ring associated with first moment of area about ξ_3-axis

$E\Gamma_2$ stiffness of ring associated with first moment of area about ξ_1-axis

$E\Gamma_3, E\Gamma_4, E\Gamma_5, E\Gamma_6$ warping parameter for ring cross section, defined in table III

e_1 middle-surface meridional strain

e_2 middle-surface circumferential strain

e_{12} middle-surface shear strain

e_1^T total meridional strain at extreme fiber

e_2^T total circumferential strain at extreme fiber

e_{12}^T total shear strain at extreme fiber

G shear modulus for ring

G_{12} shear modulus

GJ	torsional stiffness of ring
h	total thickness of shell wall
K	number of finite elements used to represent a shell
$K_{11}, K_{12}, K_{22}, K_{66}$	stiffness parameters representing interaction between in-plane and out-of-plane strains
$\bar{K}$	stiffness matrix for ring
M_1	meridional moment resultant
M_2	circumferential moment resultant
M_{12}	twisting moment resultant
$\bar{M}$	mass matrix for ring
m_1	mass of ring per unit circumferential length
m_2	mass moment of inertia of ring cross section about ξ_3-axis
m_3	mass moment of inertia of ring cross section about ξ_1-axis
$m_1\bar{\xi}_1$	inertia of ring associated with first moment of area about ξ_3-axis
$m_1\bar{\xi}_3$	inertia of ring associated with first moment of area about ξ_1-axis
n	circumferential wave number
R_1, R_2	principal radii of curvature of shell
r	radius of shell measured in plane normal to shell axis
s	meridional coordinate
s_k	meridional distance from reference edge of shell to center of kth element

T_1 meridional stress resultant

T_2 circumferential stress resultant

T_{12} shear stress resultant

T_k inverse of matrix A_k

t time

U,V,W displacement component at origin of ring coordinate system in the ξ_1-, ξ_2-, and ξ_3-direction, respectively

U_n, V_n, W_n, α_n amplitudes of nth harmonic of displacements and rotation at origin of ring coordinate axes (see fig. 7)

u,v,w component of middle-surface displacement in meridional, circumferential, and normal direction, respectively

u_1, u_2, u_3 displacement component at a general point in ring cross section in the ξ_1-, ξ_2-, and ξ_3-direction, respectively

$u_{1,n}, u_{2,n}, u_{3,n}, \beta_{2,n}$ amplitudes of nth harmonic of displacements and rotation at a general point in ring cross section

$\hat{u}_{1,n}, \hat{u}_{2,n}, \hat{u}_{3,n}, \hat{\beta}_{2,n}$ amplitudes of nth harmonic of displacements and rotation at point on ring cross section where ring attaches to shell

u_n, v_n, w_n, β_n amplitudes of nth harmonic of displacements and rotation at point on shell middle surface

$\hat{u}_n, \hat{v}_n, \hat{w}_n, \hat{\beta}_n$ amplitudes of nth harmonic of displacements and rotation of shell at ring attachment circumference

X matrix which describes assumed form of variables appearing in strain energy of shell

x meridional coordinate measured within a single element

Y	matrix which describes assumed form of displacement components u, v, and w
z	normal distance from shell reference surface to ring attachment circumference
α	rotation about ξ_2-direction at origin of ring coordinate system
β	rotation of shell generator relative to unstrained direction
β_2	rotation about ξ_2-direction at a general point in ring cross section
γ	column matrix whose elements are coefficients of assumed displacement polynomials, also mass density of ring material
$\epsilon_{11},\epsilon_{22},\epsilon_{33}$	direct strain in the ξ_1- ξ_2-, and ξ_3-direction of the ring, respectively
ϵ_{12}	shear strain on $\xi_1\xi_2$-plane
ϵ_{13}	shear strain on $\xi_1\xi_3$-plane
ϵ_{23}	shear strain on $\xi_2\xi_3$-plane
θ	circumferential coordinate
κ_1	change in curvature in meridional direction
κ_2	change in curvature in circumferential direction
κ_{12}	twist of middle surface
ν_1	Poisson's ratio for meridional direction
ν_2	Poisson's ratio for circumferential direction
ξ_1,ξ_3	coordinates which locate a point in ring cross section (see fig. 7)
ξ_2	ring circumferential coordinate

$\hat{\xi}_1, \hat{\xi}_3$ coordinates of point of attachment of ring to shell

ρ mass density of shell

σ_1 extreme-fiber meridional stress

σ_2 extreme-fiber circumferential stress

σ_{12} extreme-fiber shear stress

ϕ angle between normal to shell axis and normal to shell surface at ring attachment circumference (see fig. 7)

ψ warping function for ring cross section

$\hat{\psi}$ warping function evaluated at attachment circumference

ω natural circular frequency

A prime denotes differentiation with respect to s.

A dot denotes differentiation with respect to time.

Special notation used in machine plots of figure 4:

M1 meridional moment resultant

M2 circumferential moment resultant

M12 twisting moment resultant

M1MAX maximum value of M1

M2MAX maximum value of M2

M12MAX maximum value of M12

N circumferential wave number

SIGMA 1 (+) outer fiber meridional stress

SIGMA 1 (-)	inner fiber meridional stress
SIGMA 2 (+)	outer fiber circumferential stress
SIGMA 2 (-)	inner fiber circumferential stress
SIGMA 12 (+)	outer fiber shear stress
SIGMA 12 (-)	inner fiber shear stress
S1MAX	maximum value of meridional stress
S2MAX	maximum value of circumferential stress
S12MAX	maximum value of shear stress
S/L	nondimensional meridional distance
T1	meridional stress resultant
T2	circumferential stress resultant
T12	shear stress resultant
T1MAX	maximum value of T1
T2MAX	maximum value of T2
T12MAX	maximum value of T12
U,V,W	middle-surface displacement component in meridional, circumferential, and normal direction, respectively
UMAX,VMAX,WMAX	maximum value of U, V, and W, respectively

GENERAL ORGANIZATION OF THE COMPUTER PROGRAM

The general organization of the computer program is illustrated in figure 1. A more detailed description of the program is available in reference 1. The arrangement of the subroutines in the source deck is shown in figure 2. The reader should take

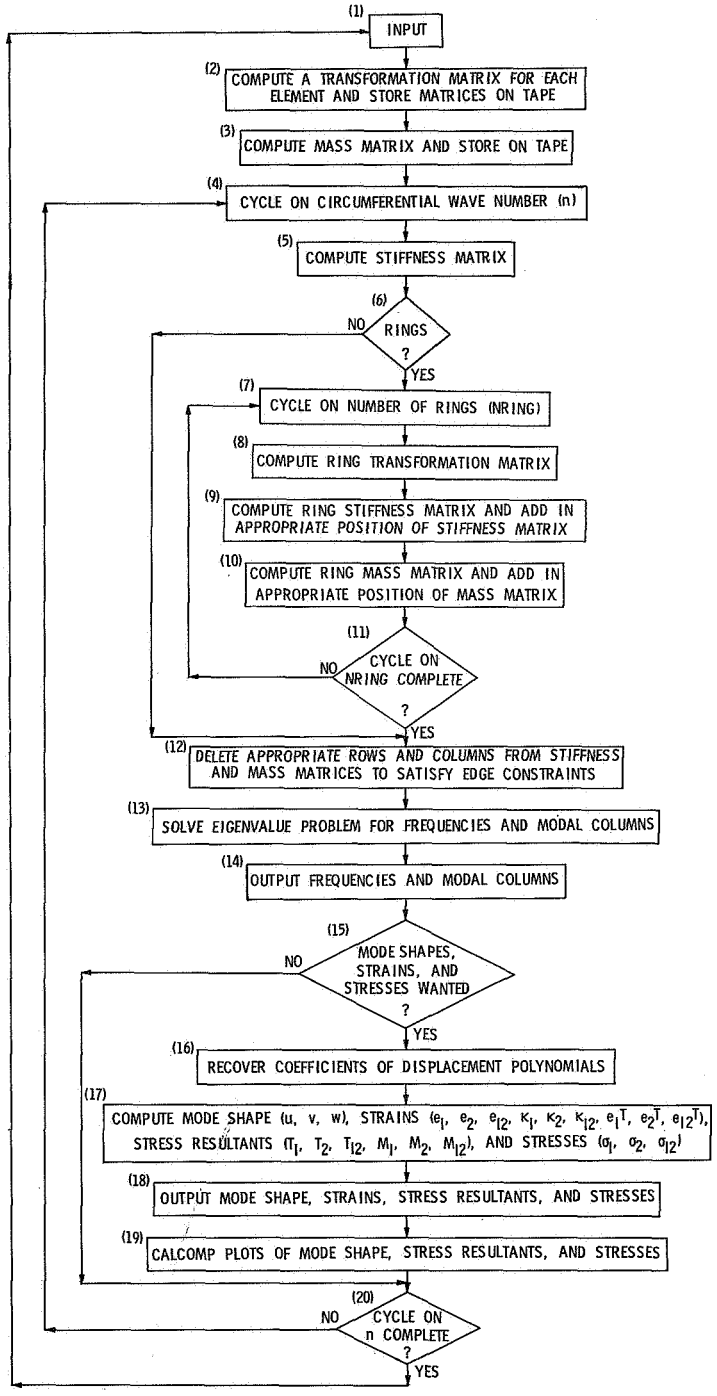


Figure 1.- General organization of program.

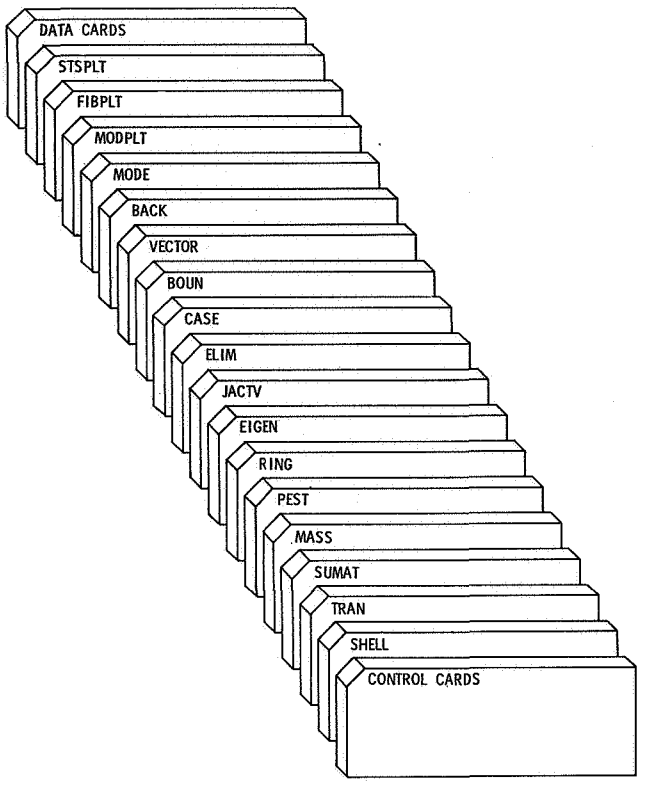


Figure 2.- Arrangement of subroutines in source deck.

particular notice of the location of subroutine PEST because, as explained later, this is the subroutine which accepts a good deal of the input to the program. A brief description of the function of each of the subroutines in the program is as follows:

SHELL — the main program, calls the subroutines in the proper sequence

TRAN — used to compute a transformation matrix for each element

SUMAT — used to compute a stiffness matrix for each element by numerical integration using the trapezoidal rule

MASS — used to compute a mass matrix for each element by numerical integration using the trapezoidal rule

PEST — used to compute the elements of matrix R (see ref. 1)

RING — used to compute a ring stiffness matrix and mass matrix for each ring and add them to the shell stiffness and mass matrices, respectively

EIGEN used to solve the final matrix equation for the natural frequencies and modal columns of the shell

JACTV used to calculate the eigenvalues and eigenvectors of a square symmetric matrix by the threshold Jacobi method, described in reference 1

ELIM deletes a row and a column from a matrix

CASE used to designate the row and column numbers to be deleted from the stiffness and mass matrices to satisfy the edge conditions

BOUN used to delete the appropriate rows and columns to satisfy the edge conditions

VECTOR used to designate, in accordance with CASE, the locations in the modal column where zeros are to be inserted

BACK used to insert zeros in the modal columns

MODE used to compute the coefficients of the polynomials which represent the displacement components. These polynomials are then used to compute mode shapes, modal strains, and modal stresses.

MODPLT used to obtain CALCOMP plots of the mode shapes

FIBPLT used to obtain CALCOMP plots of extreme-fiber modal stresses

STSPLT used to obtain CALCOMP plots of modal stress and moment resultants

INPUT

The input necessary to operate the computer program is described in this section. There are three types of input to the program:

(1) Control numbers

(2) Numerical input data

(3) Function input

In addition, the first card in the data cards must be a description of the problem being solved. This identification is an alphanumeric array IDEN and has the format 8A10.

Control Numbers

The control numbers are listed in table I.

TABLE I.- CONTROL NUMBERS

Quantity	Format
K	7I4
NBEG	↓
NLAST	
ININ	
ICASE	
NRING	
IPRINT	
NMODE	
ISTRN	
ISTRES	
IINT	
IPLOT	
IPLSTS	
IFUNCT	

The interpretation of each control number follows:

K — the number of finite elements used to represent the shell

NBEG,NLAST — specify the range of circumferential wave numbers for which calculations are performed. The first value of n is NBEG and the last is NLAST.

ININ — the number of intervals used in each element for performing the numerical integrations required to compute the element mass and stiffness matrices. The authors have found 100 intervals to be sufficient.

ICASE — defines the edge conditions of the shell being analyzed (see table III of ref. 1)

NRING — the number of rings on the shell

IPRINT controls the printing of the shell stiffness and mass matrices and also controls the number of modal columns printed.

If IPRINT is 0 the mass and stiffness matrices are not printed and only the modal columns corresponding to the five lowest frequencies are printed.

If IPRINT is 1 the mass and stiffness matrices are not printed but all the modal columns are printed.

If IPRINT is 2 the mass and stiffness matrices are printed and all the modal columns are printed.

NMODE controls the computation of mode shapes. For each circumferential wave number, mode shapes are computed for the lowest NMODE frequencies. All the computed mode shapes are printed.

ISTRN controls the computation of middle-surface and extreme-fiber modal strains.

If ISTRN is set equal to a nonzero integer distributions of modal strains are calculated and printed for the same modes for which the mode shapes were computed.

If ISTRN is zero the calculation of modal strains is omitted.

ISTRES controls the computation of modal stress resultants and outer fiber stresses.

If ISTRES is set equal to a nonzero integer distributions of stress resultants and extreme-fiber stresses are calculated and printed for the same modes for which mode shapes were computed.

If ISTRES is set equal to zero calculations of stresses and stress resultants are omitted.

Note: ISTRN may not be nonzero unless NMODE is also nonzero. Similarly, ISTRES may not be nonzero unless both ISTRN and NMODE are nonzero.

IINT one less than the number of locations within each element at which the mode shapes, modal strains, and modal stresses are computed. Ten locations are generally sufficient.

IPLOT controls the CALCOMP plotting of the mode shapes, modal strains, and modal stresses.

If IPLOT is set equal to zero neither mode shapes, modal strains, nor modal stresses are plotted.

If IPLOT is nonzero all the calculated mode shapes are plotted.

IPLSTS controls the CALCOMP plotting of the modal strains and modal stresses.

If IPLSTS is set equal to zero modal strains and stresses are not plotted.

If IPLSTS is nonzero all the calculated strains and stresses are plotted.

IFUNCT indicates which of two options the user wishes to use to input the properties of the shell.

If IFUNCT is zero the material properties are read in as constants on data cards. This option is obviously used only for shells with constant properties.

If IFUNCT is nonzero the material properties are entered directly into the subroutine PEST as functions of the meridional coordinate s.

Elucidation of the two options will be made in later sections of the paper when numerical data and function input data are discussed.

Numerical Input Data

The numerical input data are listed in table II.

TABLE II.- NUMERICAL INPUT DATA

Quantity	Format
SO	5E14.8
E(I)	↓
YOUNG1	
YOUNG2	
XMU1	
XMU2	
RHO	
TH	
G12	
NJUN(I)	7I4
RIN(J,I)	5E14.8

A description of each of the items in table II follows:

SO the meridional distance from the origin of the meridional coordinate s to the reference edge of the shell

E(I) an array in which the Ith entry is the meridional length of the Ith finite element. There must be K of these entries. Furthermore, the sum of the E(I)'s must be equal to the meridional length of the shell.

YOUNG1 Young's modulus in the meridional direction. This input is used only if IFUNCT = 0.

YOUNG2 Young's modulus in the circumferential direction. This input is used only if IFUNCT = 0.

XMU1 Poisson's ratio in the meridional direction. This input is used only if IFUNCT = 0.

XMU2 Poisson's ratio in the circumferential direction. This input is used only if IFUNCT = 0.

RHO mass density for the shell material

TH the shell thickness. This input is used only if IFUNCT = 0.

G12 the shear modulus. This input is used only if IFUNCT = 0.

NJUN(I) an array in which the Ith entry is the juncture at which the Ith ring is located. The number of entries in the array is equal to NRING. If NRING = 0, reading of the array NJUN(I) is omitted.

As is noted in appendix C, a requirement of the program is that rings be located only at element junctures.

RIN(J,I) a two-dimensional array defining the ring properties. An element in this array specifies the Jth property of the Ith ring. The range on J is 1 to 21 and the range on I is 1 to NRING. The definitions of each of the 21 properties required are given in table III.

TABLE III.- RING PROPERTIES FOR INPUT

Program designation	Symbol used in appendix C	Definition as given in appendix C
RIN(1,I)	$\hat{\psi}$	$\psi(\hat{\xi}_1, \hat{\xi}_3)$
RIN(2,I)	$\hat{\xi}_1$	ξ_1 coordinate of the attachment circumference
RIN(3,I)	$\hat{\xi}_3$	ξ_3 coordinate of the attachment circumference
RIN(4,I)	ϕ	Angle between normal to axis and normal to shell surface at attachment circumference
RIN(5,I)	EI_1	$\int_A E\xi_3^2 \, dA$
RIN(6,I)	EI_3	$\int_A E\xi_1^2 \, dA$
RIN(7,I)	EI_{13}	$\int_A E\xi_1\xi_3 \, dA$
RIN(8,I)	$E\Gamma_1$	$\int_A E\xi_1 \, dA$
RIN(9,I)	$E\Gamma_2$	$\int_A E\xi_3 \, dA$
RIN(10,I)	EA	$\int_A E \, dA$
RIN(11,I)	$E\Gamma_3$	$\int_A E\psi^2 \, dA$
RIN(12,I)	$E\Gamma_4$	$\int_A E\psi\xi_1 \, dA$
RIN(13,I)	$E\Gamma_5$	$\int_A E\psi\xi_3 \, dA$
RIN(14,I)	$E\Gamma_6$	$\int_A E\psi \, dA$
RIN(15,I)	GJ	$\int_A G\left[\left(\frac{\partial\psi}{\partial\xi_3} - \frac{\psi}{a} + \xi_1\right)^2 + \left(\frac{\partial\psi}{\partial\xi_1} - \xi_3\right)^2\right] dA$
RIN(16,I)	z	Normal distance from shell reference surface to ring attachment circumference
RIN(17,I)	m_1	$\int_A \gamma \, dA$
RIN(18,I)	$m_1\bar{\xi}_3$	$\int_A \gamma\xi_3 \, dA$
RIN(19,I)	$m_1\bar{\xi}_1$	$\int_A \gamma\xi_1 \, dA$
RIN(20,I)	m_2	$\int_A \gamma\xi_1^2 \, dA$
RIN(21,I)	m_3	$\int_A \gamma\xi_3^2 \, dA$

Explanation of Items in Table III

As can be seen from table III the warping function $\psi(\xi_1, \xi_3)$ is required in several items. The authors are unaware of a suitable procedure for determining ψ for rings having general cross sections. It is suggested in reference 2 that this function be approximated by the warping function of St. Venant torsion theory for straight bars. The validity of this approximation has not been investigated by the authors of the present report. The authors have, however, obtained satisfactory results for frequencies of stiffened shells by approximating the items in table III which involve ψ as follows:

$$\hat{\psi} = 0$$

$$E\Gamma_3 = EC_w$$

$$E\Gamma_4 = E\Gamma_5 = E\Gamma_6 = 0$$

$$GJ = \int_A G\left(\xi_1^2 + \xi_3^2\right) dA$$

where C_w is the warping constant from St. Venant torsion theory for straight bars and E is the average value of Young's modulus over the ring cross section.

Explanations of the remaining items in table III are as follows:

$\hat{\xi}_1, \hat{\xi}_3$ — coordinates which locate a point in ring cross section, can be positive or negative

ϕ — angle between normal to shell axis and normal to shell surface at ring attachment circumference

EI_1, EI_3 — bending stiffness about ξ_1- and ξ_3-axis, respectively

EI_{13} — bending stiffness due to coupling between bending about ξ_1- and ξ_3-axes

$E\Gamma_1$ — stiffness associated with first moment of area about ξ_3-axis

$E\Gamma_2$ — stiffness associated with first moment of area about ξ_1-axis

EA — extensional stiffness of ring

z — normal distance from shell reference surface to ring attachment circumference, $-\frac{h}{2} \leq z \leq \frac{h}{2}$

m_1 — mass of ring per unit circumferential length

$m_1\bar{\xi}_3$ — inertia associated with first moment of area about ξ_1-axis

$m_1\bar{\xi}_1$ — inertia associated with first moment of area about ξ_3-axis

m_2 — mass moment of inertia about ξ_3-axis

m_3 — mass moment of inertia about ξ_1-axis

The quantity a is required in several of the matrices which describe the ring. This quantity is the distance from the shell axis to the origin of the ring coordinate system. (See appendix C.) From the first figure in appendix C it is seen that a is determined for each ring by the following equation:

$$a = r + z \cos \phi - \hat{\xi}_3$$

where r is the shell radius at the ring location and z, ϕ, and $\hat{\xi}_3$ have been previously defined. The location of the origin of the ξ_1, ξ_3 coordinate system is arbitrary; however, the most convenient choice is the centroid of the cross section.

Function Input

The function input is in the form of FORTRAN statements which are placed in the subroutine PEST. The function input is of two types:

(1) Functions describing the geometry of the reference surface of the shell

(2) Functions describing the thickness and material properties of the shell wall

Function input of the first type is shown in table IV. In the left column of this table are the FORTRAN words used in PEST and in the right column are the symbols used in reference 1.

TABLE IV.- FUNCTION INPUT DESCRIBING GEOMETRY OF REFERENCE SURFACE

Function	Symbol used in reference 1
R	$r(s)$
RP	$r'(s)$
R1	$1/R_1(s)$
R1P	$R_1'(s)$
R2	$1/R_2(s)$

The functions in table IV must be supplied by the user. For every shell having a different geometry, a different set of these functions is required.

Function input of the second type is summarized in table V. In the left column of the table are the FORTRAN words used in PEST. In the right column are the symbols used in reference 1 and appendix B of the present paper.

TABLE V.- FUNCTION INPUT DESCRIBING MATERIAL PROPERTIES OF SHELL WALL

Function	Symbol used in reference 1 and appendix B
C11	$C_{11}(s)$
C12	$C_{12}(s)$
C22	$C_{22}(s)$
C66	$C_{66}(s)$
D11	$D_{11}(s)$
D12	$D_{12}(s)$
D22	$D_{22}(s)$
D66	$D_{66}(s)$
K11	$K_{11}(s)$
K12	$K_{12}(s)$
K22	$K_{22}(s)$
K66	$K_{66}(s)$
Young1	$E_1(s)$
Young2	$E_2(s)$

TABLE V.- FUNCTION INPUT DESCRIBING MATERIAL PROPERTIES OF SHELL WALL – Concluded

Function	Symbol used in reference 1 and appendix B
XMU1	$\nu_1(s)$
XMU2	$\nu_2(s)$
RHO	$\rho(s)$
TH	h(s)
G12	$G_{12}(s)$

Method of Specifying Function Input

It is important to note that all the functions listed in table V must be specified in PEST. The specific method of specifying these functions is dependent on the nature of the shell and the preference of the user. Three alternate methods are as follows:

(1) If the material properties and thickness of the shell are constant, proceed as follows:

(a) Set IFUNCT = 0

(b) Enter the input constants YOUNG1, YOUNG2, XMU1, XMU2, RHO, TH, and G12 on data cards

(c) Enter formulas in PEST which express the quantities C11, C12, C22, C66, D11, D12, D22, D66, K11, K12, K22, and K66 in terms of the constants in (b)

(2) If any of the material properties are functions, proceed as follows:

(a) Set IFUNCT equal to a nonzero integer

(b) Enter functions in PEST for all the functions in table V

or as follows:

(a) Set IFUNCT equal to a nonzero integer

(b) Enter functions in PEST for the quantities YOUNG1, YOUNG2, XMU1, XMU2, RHO, TH, and G12

(c) Enter formulas in PEST which express the quantities C11, C12, C22, C66, D11, D12, D22, D66, K11, K12, K22, and K66 in terms of the functions in (b)

The format of the function input is that of an ordinary FORTRAN statement which defines a quantity in the left column of table IV or table V.

OUTPUT

The output of the computer program is in two categories. The first is a printout of the numerical input data. The second consists of the results of the program calculations.

The first category of output, a printout of the numerical input data, includes the following items:

(1) The identification card IDEN

(2) The control numbers in table I

(3) The meridional length of each finite element

(4) The meridional distance from the origin of s to the center of each finite element

(5) The value of SO

(6) The material properties of the shell (if they are constants and read as numerical input data)

(7) The arrays of ring properties NJUN(I) and RIN(J,I)

(8) The edge conditions of the shell along with the rows and columns which were deleted from the mass and stiffness matrices

The second category of output, the results of the calculations, is dependent on the options exercised by the user. The natural frequencies for each circumferential wave number are printed without the user requesting their printing. The following items are printed only at the user's request:

(1) The shell stiffness and mass matrix (if IPRINT = 2)

(2) The modal columns. The number of modal columns printed is dependent upon the value of IPRINT.

(3) Tabulations of the mode shapes. The number of mode shapes printed is controlled by NMODE.

(4) Tabulations of middle-surface and extreme-fiber strains. The number of these is controlled by ISTRN and NMODE.

(5) Tabulations of stress resultants, moment resultants, and extreme-fiber stresses. The number of these is controlled by ISTRES and NMODE.

(6) CALCOMP plots of the items in (3), (4), and (5). The plotting is controlled by IPLOT and IPLSTS.

ADDITIONAL USER INFORMATION

Limitations of the Program

There are two types of limitations of the program. The first type is due to assumptions made in the theoretical development of the program, and the second is due to the programing.

Limitations of the first type are as follows:

(1) The program is not applicable to shells in which the shell surface intersects the axis of the shell. Thus, the program is not applicable to hemispheres, for example.

(2) The program is restricted to shells with continuous stiffness distributions.

(3) A ring must be attached to the shell along a single common circumference.

Limitations of the second type are

(1) The only consecutive cases that may be run with the same source deck are those which are for the same geometry. Thus, for example, the frequencies of a given cylinder may be computed for several different sets of edge conditions by using the same source deck and entering several different codes for ICASE. However, the frequencies of two different cylinders could not be computed with a single source deck.

(2) Although a plot tape may be generated at the user's option, the capability of obtaining CALCOMP plots is limited to Control Data computer (CDC) systems.

(3) The circumferences along which rings are joined to shells must be element junctures of the shell idealization.

(4) A shell may be supported only at the first and last edges of the shell.

Notes on Input

Formulas for the stiffnesses in table V are dependent upon the nature of the shell material as well as the layer geometry and the analyst's choice of the shell reference surface. The stiffnesses are intentionally left in a general form in order to provide the greatest possible flexibility for the analyst using the program. Reference 3 contains an excellent presentation of formulas for the stiffnesses for shells having various layer geometry and elastic properties. (See pp. 34 and 43 to 53 of ref. 3.) Those formulas may be used directly, with the exception that the values used for D_{66} should be four times and for K_{66} should be two times the corresponding values given in reference 3. For the reason for these exceptions refer to page 9 of reference 1. The numerical input data and the function input may be expressed in any consistent set of units.

Number and Spacing of Elements

The required number and spacing of elements in a finite-element idealization of a shell is dependent upon the nature of the results which are required as well as upon the nature of the shell. It is therefore difficult to give a user more than very general guidelines concerning how to idealize a shell by finite elements. The authors believe that the best way to suggest guidelines is to describe some of the applications that they and other users have made of the computer program.

In reference 1 it was found that the first four or five frequencies of unstiffened shells of revolution for a given circumferential harmonic are computed very accurately with 10 equally spaced elements. In reference 4 it was found that the mode shape and modal stress in a mode of a clamped cylinder which exhibited a severe boundary layer in the stress could be accurately computed with only 14 elements if the elements near the clamped edge were much smaller than those elements in the middle region of the shell.

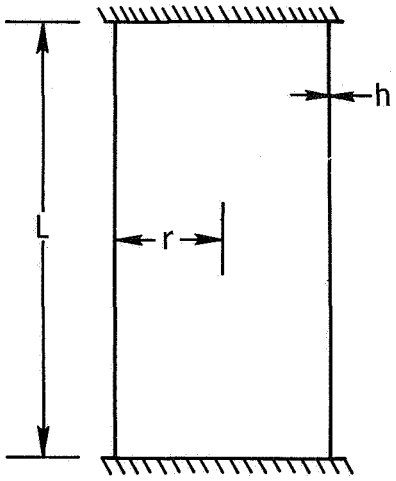
In reference 5 modes from the present computer program were used in an application of modal superposition to the prediction of axisymmetric wave propagation phenomena in cylindrical shells. A great number of modes were computed by the program with a high degree of accuracy, based on idealizations of 20 equally spaced elements. In one instance an idealization of 40 equally spaced elements was required in order to obtain the converged axial stress resultants.

SAMPLE CALCULATIONS

Two sample calculations are presented in order to illustrate the application of the computer program to typical shell configurations. The units used in the sample calculations are inches, pounds, and seconds.

Sample Calculation 1

The shell treated in the first sample calculation is a circular cylinder clamped at each edge. The geometry and material properties of the cylinder are shown in figure 3. It is desired to compute all the natural frequencies for $n = 3$ and the mode shape, modal strains, stress resultants, and extreme-fiber stresses for the lowest frequency. Printouts of the stiffness and mass matrices are not required. However, it is desired to plot the mode shape and all the modal strain and stress quantities for the lowest frequency. The analysis is based on an idealization of the shell by 14 elements with the elements near the edges smaller than those near the middle. A total of 100 integration intervals is used within each element. The mode shapes and modal strain and stress parameters are to be computed and plotted at 10 equally spaced locations within each



LENGTH	L	12
RADIUS	r	3
THICKNESS	h	0.01
YOUNG'S MODULUS	E	3×10^{7}
POISSON'S RATIO	ν	0.30
MASS DENSITY	ρ	7.33×10^{-4}

Figure 3.- Circular cylinder used in sample calculation 1.

element. It is convenient for input purposes to let the reference edge of the shell be the origin of the coordinate s. Thus SO = 0.0.

The numerical data and control number input are as follows:

IDEN: SAMPLE CASE 1 CLAMPED-CLAMPED CYLINDER

K = 14

NBEG = 3

NLAST = 3

ININ = 100

ICASE = 10

NRING = 0

IPRINT = 0

NMODE = 1

ISTRN = 1

ISTRES = 1

IINT = 10

IPLOT = 1

IPLSTS = 1

IFUNCT = 0

SO = 0.0

E(1) = 0.3	E(6) = 0.6	E(11) = 0.3
E(2) = 0.3	E(7) = 3.6	E(12) = 0.3
E(3) = 0.3	E(8) = 3.6	E(13) = 0.3
E(4) = 0.3	E(9) = 0.6	E(14) = 0.3
E(5) = 0.6	E(10) = 0.6	

YOUNG1 = YOUNG2 = 3.0×10^{7}

XMU1 = XMU2 = 0.3

RHO = $7.33160620 \times 10^{-4}$

TH = 0.01

G12 = 1.1538462×10^{7}

The function input is

R = 3.0

RP = 0.0

R1 = 0.0

R1P = 0.0

R2 = 1./3.

C11 = YOUNG1*TH/(1.-XMU1**2)

C12 = XMU1*C11

C22 = C11

C66 = YOUNG1*TH/(2.*(1.+XMU1))

D11 = YOUNG1*TH**3/(12.*(1.-XMU1**2))

D12 = XMU1*D11

D22 = D11

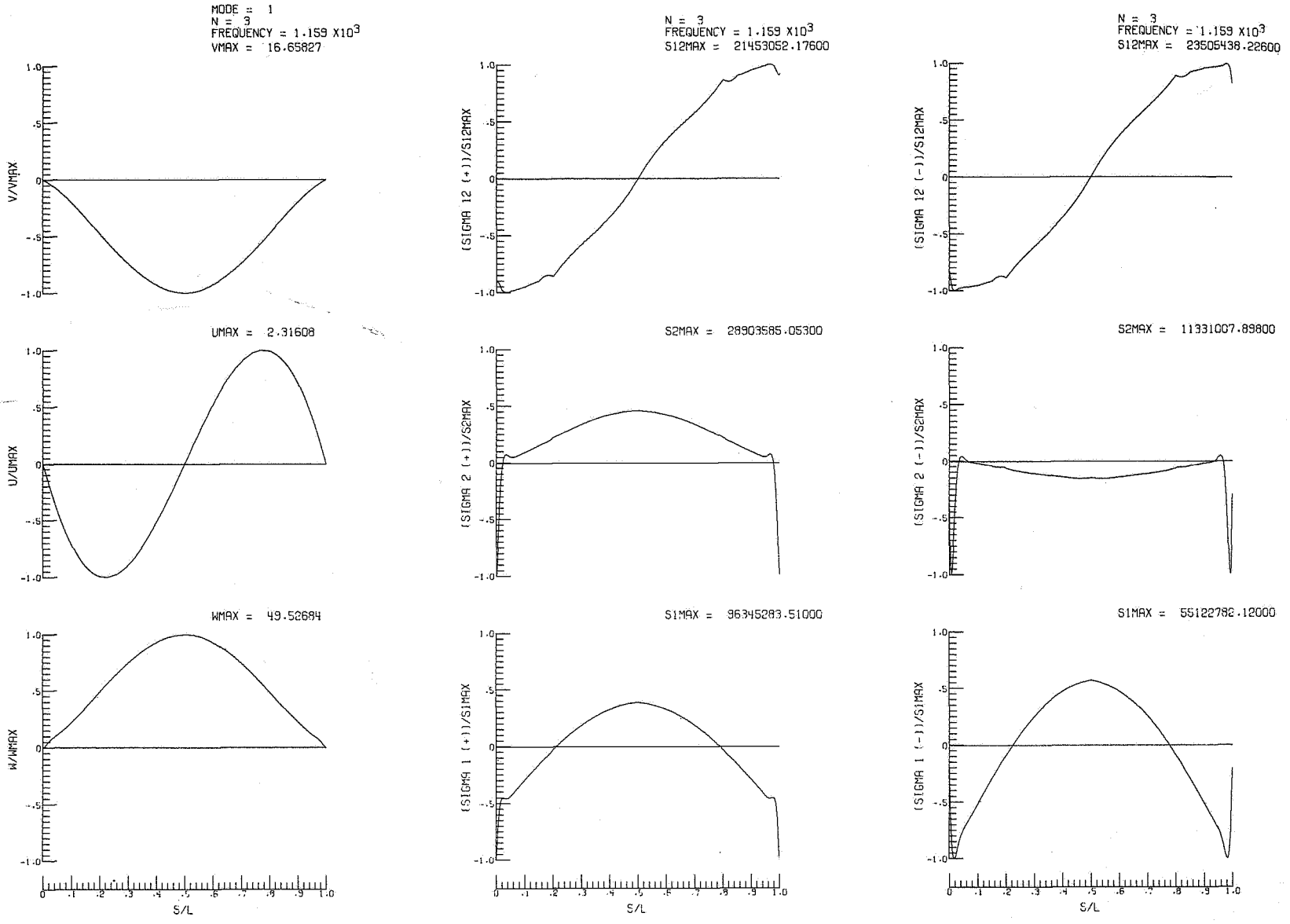
D66 = YOUNG1*TH**3/(6.*(1.+XMU1))

K11 = 0.0

K12 = 0.0

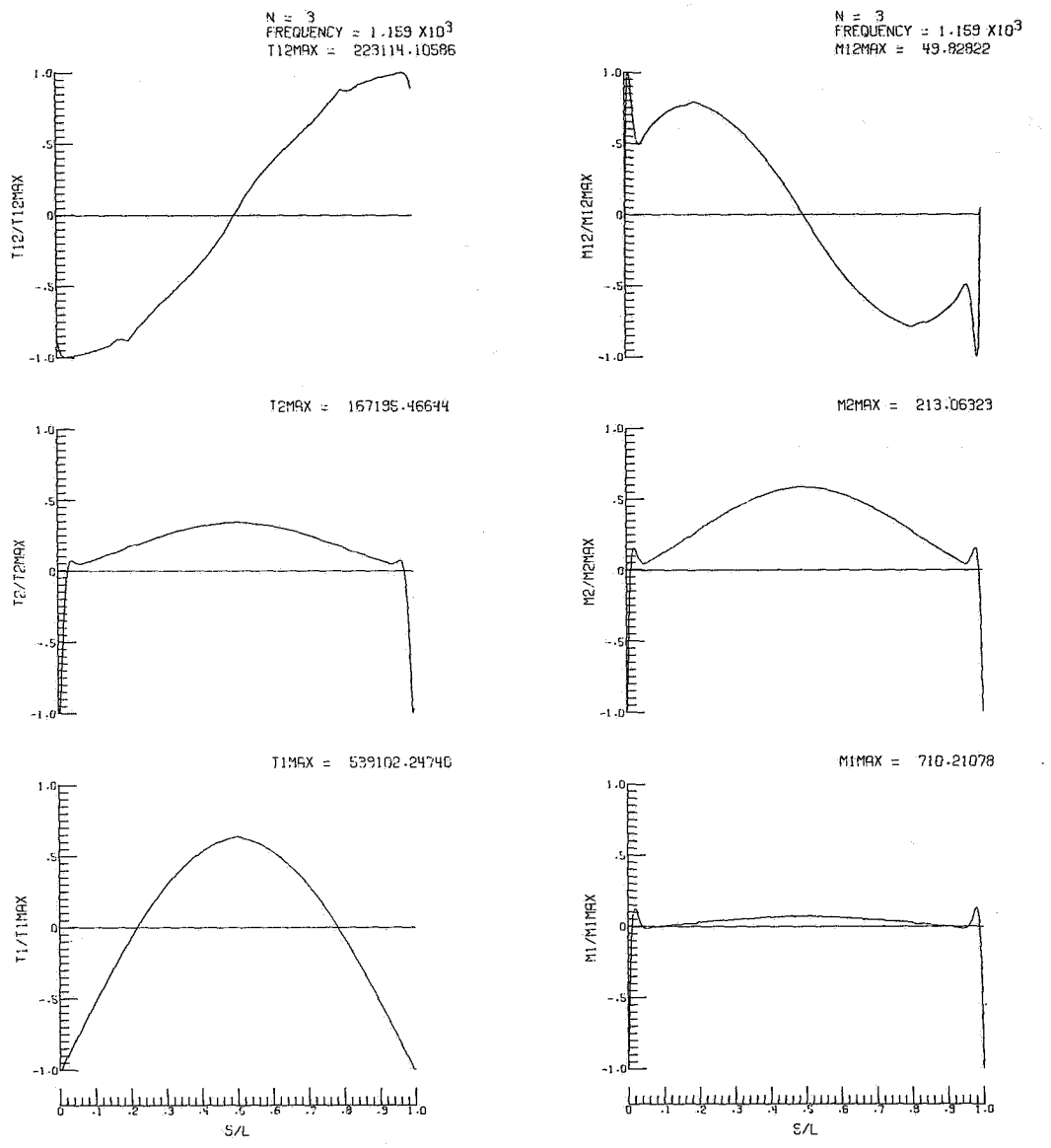
K22 = 0.0

K66 = 0.0



(a) Mode shape. (b) Outer fiber stresses. (c) Inner fiber stresses.

Figure 4.- Machine plots of results from sample calculation 1.



(d) Stress resultants. (e) Moment resultants.

Figure 4.- Concluded.

The actual coding sheets for sample calculation 1 are shown in table VI (at back of text). The printed output is shown in table VII and the plotted output is shown in figure 4.

Sample Calculation 2

The object of this calculation is to obtain the vibration characteristics of the ring-stiffened conical shell shown in figure 5. It is desired to obtain the natural frequencies

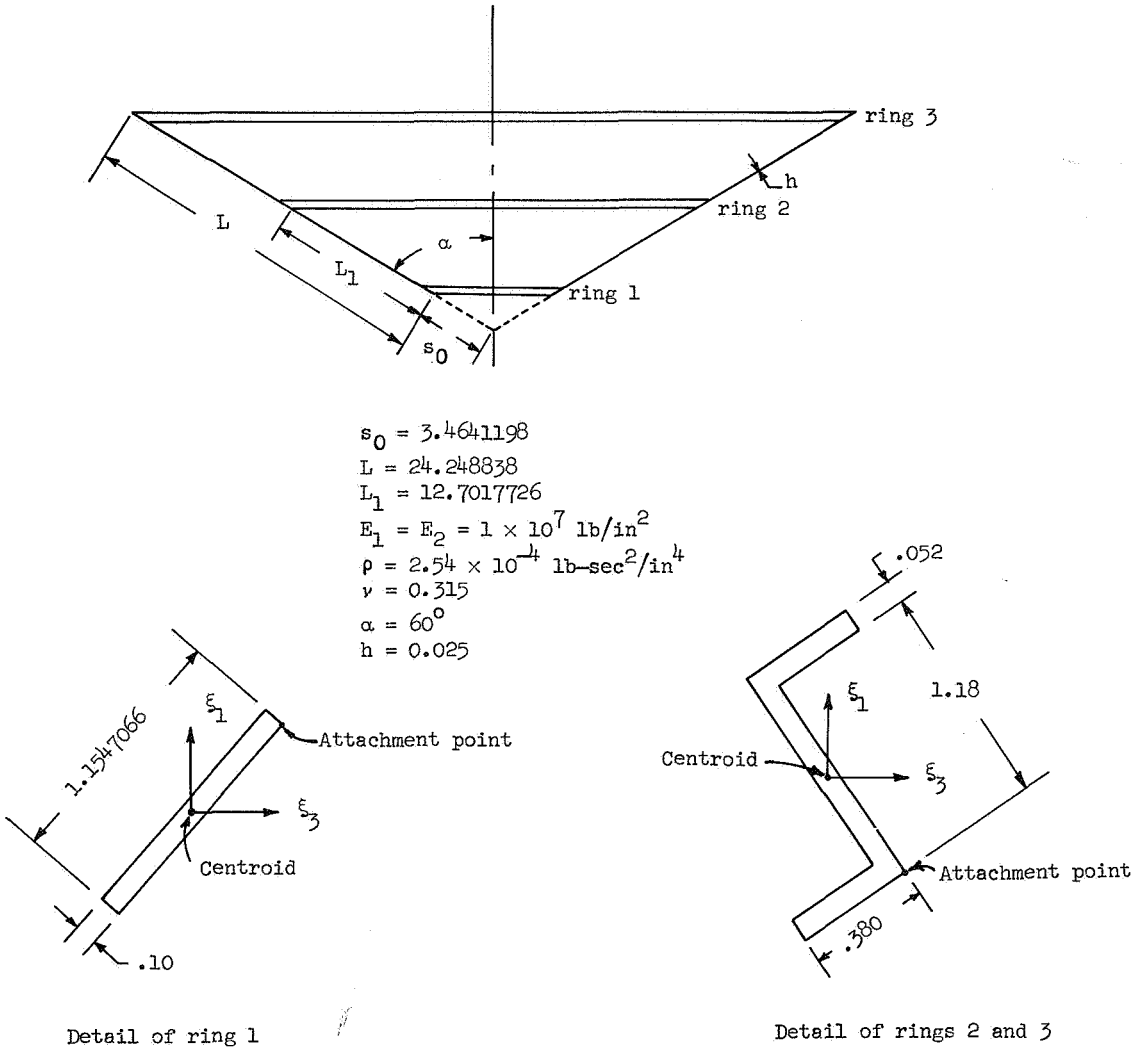


Figure 5.- Ring-stiffened conical frustum of sample calculation 2. All dimensions are in inches unless otherwise specified.

of the structure for the circumferential harmonics n = 0, 1, and 2 and to print out the modal columns corresponding to the lowest five natural frequencies, with no mass and stiffness matrix printing. Clamped boundary conditions are to be applied at the small-diameter end, and the large-diameter end is to be free. Neither mode shapes, strains, nor stresses are required. This calculation is based on an idealization by 11 elements, 10 of which are of equal length and one which is one-half of that length. One hundred integration intervals were used on each element. The layout of the elements is such that a shell element boundary is located at each ring as is required by the program.

For this sample calculation the entries for the ring properties of table III are based on the approximations discussed previously in addition to a number of commonly accepted engineering approximations. The reader's attention is directed to the following entries:

$\hat{\psi} = 0$ for all rings (see "Explanation of Items in Table III")

$E\Gamma_1 = E\Gamma_2 = 0$ since ξ_1 and ξ_3 are centroidal axes

$E\Gamma_3 = EC_w$ where C_w is the warping constant computed from formulas in table A-3 of reference 6

$E\Gamma_4 = E\Gamma_5 = E\Gamma_6 = 0$ (see "Explanation of Items in Table III")

$GJ = \frac{G}{3} Lt^3$ the usual approximation used in the torsion of thin bars. It is valid for thin sections comprised of connected rectangles all of thickness t. The sum of the lengths of the rectangles is L.

$m_1\bar{\xi}_3 = m_1\bar{\xi}_1 = 0$ since ξ_1 and ξ_3 are centroidal axes

$m_2 = m_3 = 0$ neglects rotary inertia of the ring cross section

Each ring is assumed to be attached to the shell at the inner surface of the shell. The point on each ring where it is attached to the shell is shown in figure 5.

The numerical data and control number input for the second sample calculations are as follows:

IDEN: SAMPLE CASE 2 CLAMPED-FREE 60-DEGREE CONE WITH THREE RINGS

K = 11

NBEG = 0

NLAST = 2

ININ = 100

ICASE = 7

NRING = 3

IPRINT = 0

NMODE = 0

ISTRN = 0

ISTRES = 0

IINT = 0

IPLOT = 0

IPLSTS = 0

IFUNCT = 0

SO = 3.4641198

E(1) = 1.1547066
E(2) = 2.3094132
E(3) = 2.3094132
E(4) = 2.3094132
E(5) = 2.3094132
E(6) = 2.3094132
E(7) = 2.3094132
E(8) = 2.3094132
E(9) = 2.3094132
E(10) = 2.3094132
E(11) = 2.3094132

YOUNG1 = YOUNG2 = 1.0×10^7

XMU1 = XMU2 = 0.315

RHO = 0.000254

TH = 0.025

G12 = 3.8561538×10^6

NJUN(1) = 2

NJUN(2) = 7

NJUN(3) = 12

The ring inputs in table III are as follows:

RIN(J,I) for –			
J	I		
	1	2	3
1	0	0	0
2	0.24537	-0.497956	-0.497956
3	0.525	0.317517	0.317517
4	-60.0	-60.0	-60.0
5	32 797.211	24 922	24 922
6	96 467.124	170 370	170 370
7	55 139.761	-52 855	-52 855
8	0	0	0
9	0	0	0
10	1 154 706.6	954 720	954 720
11	165.2	3477.1	3477.1
12	0	0	0
13	0	0	0
14	0	0	0
15	1 463.5064	327.19428	327.19428
16	-0.0125	-0.0125	-0.0125
17	0.000029329547	0.00002425	0.00002425
18	0	0	0
19	0	0	0
20	0	0	0
21	0	0	0

The function input is

```
PI = 3.14159265358979
RP = SIN(PI/3.)
R = S*RP
R1 = 0.0
R1P = 0.0
R2 = COS(PI/3.)/R
C11 = YOUNG1*TH/(1.0-XMU1**2)
```

```
C12 = XMU1*C11
C22 = C11
C66 = YOUNG1*TH/(2.0*(1.0+XMU1))
D11 = YOUNG1*TH**3/(12.0*(1.0-XMU1**2))
D12 = XMU1*D11
D22 = D11
D66 = YOUNG1*TH**3/(6.0*(1.0+XMU1))
K11 = 0.0
K12 = 0.0
K22 = 0.0
K66 = 0.0
```

The actual coding sheets for sample calculation 2 are shown in table VIII. The printed output is shown in table IX.

CONCLUDING REMARKS

A user's manual for the operation of a digital computer program for calculation of the vibration characteristics of orthotropic thin shells of revolution has been presented. Included in this manual are input and output parameter definitions, input coding information, and the various computing options available to the user. Two sample calculations are presented to illustrate the use of the program.

Langley Research Center,
National Aeronautics and Space Administration,
Hampton, Va., August 14, 1970.

APPENDIX A

MODIFICATION OF ANALYSIS OF NASA TN D-4972 TO ACCOUNT FOR HIGHER ORDER DISPLACEMENT FIELD

In reference 1 the displacement field within each element was given in equations (7) of that document as

$$\left.\begin{aligned} w &= a_{0,k} + a_{1,k}x + a_{2,k}x^2 + a_{3,k}x^3 \\ u &= b_{0,k} + b_{1,k}x + b_{2,k}x^2 + b_{3,k}x^3 \\ v &= c_{0,k} + c_{1,k}x + c_{2,k}x^2 + c_{3,k}x^3 \end{aligned}\right\} \tag{A1}$$

In the version of the computer program described in this paper, u and v are represented as in reference 1, but w is approximated as

$$w = a_{0,k} + a_{1,k}x + a_{2,k}x^2 + a_{3,k}x^3 + a_{4,k}x^4 + a_{5,k}x^5$$

The purpose of this appendix is to summarize the differences between the present version of the program and the version described in reference 1 as a result of the higher order approximation of w.

In equations (7), replace the first equation by

$$w = a_{0,k} + a_{1,k}x + a_{2,k}x^2 + a_{3,k}x^3 + a_{4,k}x^4 + a_{5,k}x^5$$

Replace equation (8) by

$$\begin{Bmatrix} w \\ w' \\ w'' \\ u \\ u' \\ v \\ v' \end{Bmatrix} = [X] \begin{Bmatrix} a_{0,k} \\ a_{1,k} \\ a_{2,k} \\ a_{3,k} \\ a_{4,k} \\ a_{5,k} \\ b_{0,k} \\ b_{1,k} \\ b_{2,k} \\ b_{3,k} \\ c_{0,k} \\ c_{1,k} \\ c_{2,k} \\ c_{3,k} \end{Bmatrix}$$

Replace equation (9) by

$$[X] = \begin{bmatrix} 1 & x & x^2 & x^3 & x^4 & x^5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 2x & 3x^2 & 4x^3 & 5x^4 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 2 & 6x & 12x^2 & 20x^3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & x & x^2 & x^3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 2x & 3x^2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & x & x^2 & x^3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 2x & 3x^2 \end{bmatrix}$$

Replace equation (13) by

$$\begin{Bmatrix} w_k \\ u_k \\ v_k \\ \beta_k \\ u'_k \\ v'_k \\ \beta'_k \\ w_{k+1} \\ u_{k+1} \\ v_{k+1} \\ \beta_{k+1} \\ u'_{k+1} \\ v'_{k+1} \\ \beta'_{k+1} \end{Bmatrix} = \left[A_k\right] \begin{Bmatrix} a_{0,k} \\ a_{1,k} \\ a_{2,k} \\ a_{3,k} \\ a_{4,k} \\ a_{5,k} \\ b_{0,k} \\ b_{1,k} \\ b_{2,k} \\ b_{3,k} \\ c_{0,k} \\ c_{1,k} \\ c_{2,k} \\ c_{3,k} \end{Bmatrix}$$

Replace equation (14) by

$$\begin{Bmatrix} a_{0,k} \\ a_{1,k} \\ a_{2,k} \\ a_{3,k} \\ a_{4,k} \\ a_{5,k} \\ b_{0,k} \\ b_{1,k} \\ b_{2,k} \\ b_{3,k} \\ c_{0,k} \\ c_{1,k} \\ c_{2,k} \\ c_{3,k} \end{Bmatrix} = \left[T_k\right] \begin{Bmatrix} w_k \\ u_k \\ v_k \\ \beta_k \\ u'_k \\ v'_k \\ \beta'_k \\ w_{k+1} \\ u_{k+1} \\ v_{k+1} \\ \beta_{k+1} \\ u'_{k+1} \\ v'_{k+1} \\ \beta'_{k+1} \end{Bmatrix}$$

The quantity β' is the meridional derivative of the meridional rotation; that is, $\beta' = \partial\beta/\partial s$.

Replace equation (18) by

$$\{\gamma\} = \begin{Bmatrix} a_{0,k} \\ a_{1,k} \\ a_{2,k} \\ a_{3,k} \\ a_{4,k} \\ a_{5,k} \\ b_{0,k} \\ b_{1,k} \\ b_{2,k} \\ b_{3,k} \\ c_{0,k} \\ c_{1,k} \\ c_{2,k} \\ c_{3,k} \end{Bmatrix}$$

Replace equation (22) by

$$\{\xi\} = \begin{Bmatrix} w_k \\ u_k \\ v_k \\ \beta_k \\ u'_k \\ v'_k \\ \beta'_k \\ w_{k+1} \\ u_{k+1} \\ v_{k+1} \\ \beta_{k+1} \\ u'_{k+1} \\ v'_{k+1} \\ \beta'_{k+1} \end{Bmatrix}$$

Replace equation (26) by

$$[Y] = \begin{bmatrix} 1 & x & x^2 & x^3 & x^4 & x^5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & x & x^2 & x^3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & x & x^2 & x^3 \end{bmatrix}$$

Replace equation (33) by

$$\underbrace{\begin{Bmatrix} w_{k+1} \\ u_{k+1} \\ v_{k+1} \\ \beta_{k+1} \\ u'_{k+1} \\ v'_{k+1} \\ \beta'_{k+1} \end{Bmatrix}}_{\text{kth element}} = \underbrace{\begin{Bmatrix} w_{k+1} \\ u_{k+1} \\ v_{k+1} \\ \beta_{k+1} \\ u'_{k+1} \\ v'_{k+1} \\ \beta'_{k+1} \end{Bmatrix}}_{\text{k+1st element}} \qquad (k < K)$$

Changes on page 17:

The order of matrices S and M is $7(K + 1)$.

Replace references to "6×6 block . . ." with "7×7 block . . ."

Last sentence before equation (36) should read ". . ., $7(K + 1)$ in number:"

Add to equation (36)

$$\frac{\partial (E - V)}{\partial \beta'_k} = 0$$

Changes on page 18:

First sentence of second paragraph should begin: "Equation (37) determines $7(K + 1)$ natural frequencies . . . ."

The first of equations (38) should be changed to

$$w = a_{0,k} + a_{1,k}(s - s_k) + a_{2,k}(s - s_k)^2 + a_{3,k}(s - s_k)^3 + a_{4,k}(s - s_k)^4 + a_{5,k}(s - s_k)^5$$

Changes on page 22:

BLOCK 5:

$KN = 7(K + 1)$

BLOCK 8:

"The elements of $[T_k]$, a 14×14 matrix . . . ."

Changes on page 26:

BLOCK 21:

Same as equation (14)

BLOCK 22:

Formula for w should be revised as for equation (38).

Changes in tables and figures:

Table I:

The new matrix A_k is given in table X.

Table II:

The new matrix T_k is given in table XI.

Table III:

Wherever the row and column designation 6K+1, 6K+2, 6K+3, or 6K+4 appear, they should be replaced by 7K+1, 7K+2, 7K+3, or 7K+4, respectively.

Figure 3:

The new figure 3 is shown as figure 6 of the present paper.

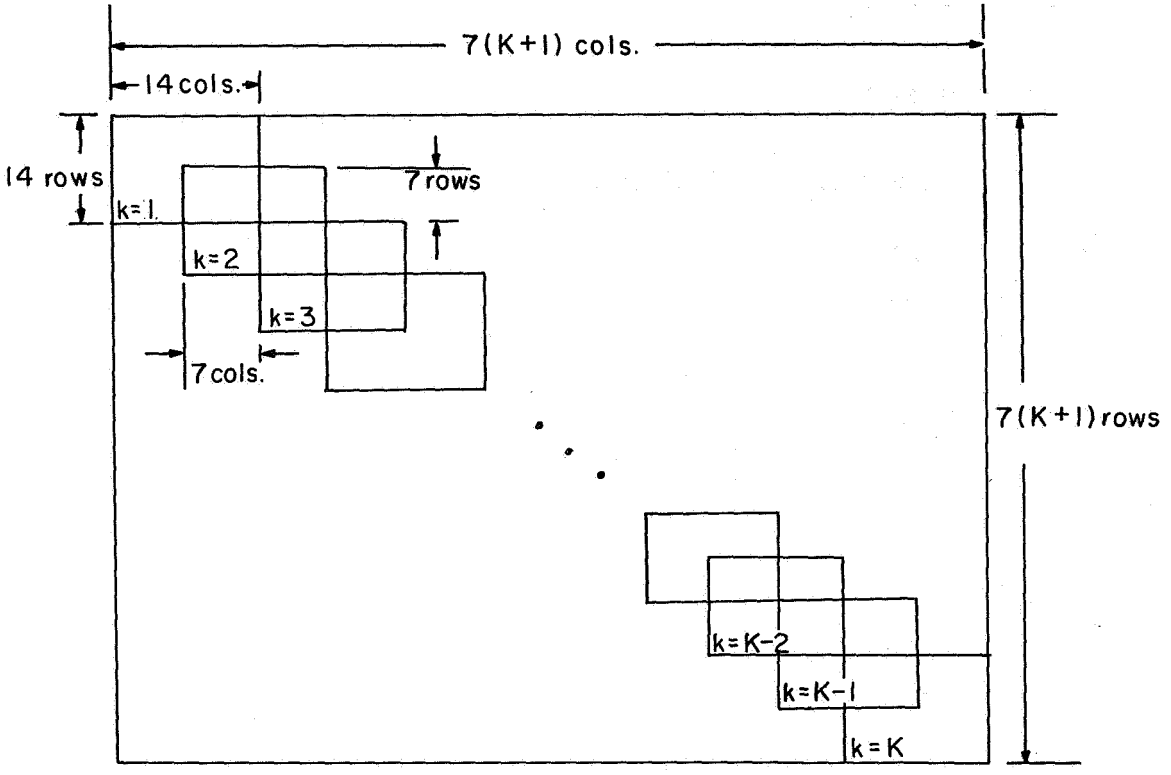


Figure 6.- Illustration of synthesis of stiffness and mass matrices.

APPENDIX B

CALCULATIONS OF MODAL STRESSES, STRAINS, STRESS RESULTANTS, AND MOMENT RESULTANTS

Middle-Surface Strains and Changes in Curvature

The formulas for middle-surface strains and changes in curvature are given in reference 1. They are repeated here for completeness.

$$\left.\begin{aligned}
e_1 &= u' + \frac{w}{R_1} \\
e_2 &= \frac{1}{r}\frac{\partial v}{\partial \theta} + \frac{1}{r} r'u + \frac{w}{R_2} \\
e_{12} &= \frac{1}{r}\frac{\partial u}{\partial \theta} + v' - \frac{1}{r} r'v \\
\kappa_1 &= -w'' + \frac{1}{R_1} u' - \frac{1}{R_1^2} R_1' u \\
\kappa_2 &= -\frac{1}{r^2}\frac{\partial^2 w}{\partial \theta^2} + \frac{1}{rR_2}\frac{\partial v}{\partial \theta} - \frac{r'w'}{r} + \frac{1}{rR_1} r'u \\
\kappa_{12} &= -\frac{1}{r}\frac{\partial w'}{\partial \theta} + \frac{1}{r^2} r' \frac{\partial w}{\partial \theta} + \frac{1}{rR_1}\frac{\partial u}{\partial \theta} + \frac{v'}{R_2} - \frac{1}{rR_2} r'v
\end{aligned}\right\} \qquad \text{(B1)}$$

In reference 1 it was assumed that the three components of middle-surface displacement had the following form:

$$\left.\begin{aligned}
\bar{u}(s,\theta,t) &= u(s) \cos n\theta \, e^{i\omega t} \\
v(s,\theta,t) &= v(s) \sin n\theta \, e^{i\omega t} \\
w(s,\theta,t) &= w(s) \cos n\theta \, e^{i\omega t}
\end{aligned}\right\} \qquad \text{(B2)}$$

Substitution of equations (A1) and (B2) into equation (B1) gives the following expressions for the amplitudes of the middle-surface strains and changes of curvature within the kth element:

$$
\begin{aligned}
e_1(s) &= b_{1,k} + 2b_{2,k}(s - s_k) + 3b_{3,k}(s - s_k)^2 + \frac{1}{R_1}\Big[a_{0,k} + a_{1,k}(s - s_k) \\
&\quad + a_{2,k}(s - s_k)^2 + a_{3,k}(s - s_k)^3 + a_{4,k}(s - s_k)^4 + a_{5,k}(s - s_k)^5\Big] \\
\\
e_2(s) &= \frac{n}{r}\Big[c_{0,k} + c_{1,k}(s - s_k) + c_{2,k}(s - s_k)^2 + c_{3,k}(s - s_k)^3\Big] + \frac{r'}{r}\Big[b_{0,k} + b_{1,k}(s - s_k) \\
&\quad + b_{2,k}(s - s_k)^2 + b_{3,k}(s - s_k)^3\Big] + \frac{1}{R_2}\Big[a_{0,k} + a_{1,k}(s - s_k) + a_{2,k}(s - s_k)^2 \\
&\quad + a_{3,k}(s - s_k)^3 + a_{4,k}(s - s_k)^4 + a_{5,k}(s - s_k)^5\Big] \\
\\
e_{12}(s) &= -\frac{n}{r}\Big[b_{0,k} + b_{1,k}(s - s_k) + b_{2,k}(s - s_k)^2 + b_{3,k}(s - s_k)^3\Big] + c_{1,k} + 2c_{2,k}(s - s_k) \\
&\quad + 3c_{3,k}(s - s_k)^2 - \frac{r'}{r}\Big[c_{0,k} + c_{1,k}(s - s_k) + c_{2,k}(s - s_k)^2 + c_{3,k}(s - s_k)^3\Big] \\
\\
\kappa_1(s) &= -2a_{2,k} - 6a_{3,k}(s - s_k) - 12a_{4,k}(s - s_k)^2 - 20a_{5,k}(s - s_k)^3 \\
&\quad + \frac{1}{R_1}\Big[b_{1,k} + 2b_{2,k}(s - s_k) + 3b_{3,k}(s - s_k)^2\Big] - \frac{R_1'}{R_1^2}\Big[b_{0,k} + b_{1,k}(s - s_k) \\
&\quad + b_{2,k}(s - s_k)^2 + b_{3,k}(s - s_k)^3\Big] \\
\\
\kappa_2(s) &= \frac{n^2}{r^2}\Big[a_{0,k} + a_{1,k}(s - s_k) + a_{2,k}(s - s_k)^2 + a_{3,k}(s - s_k)^3 + a_{4,k}(s - s_k)^4 \\
&\quad + a_{5,k}(s - s_k)^5\Big] + \frac{n}{rR_2}\Big[c_{0,k} + c_{1,k}(s - s_k) + c_{2,k}(s - s_k)^2 + c_{3,k}(s - s_k)^3\Big] \\
&\quad - \frac{r'}{r}\Big[a_{1,k} + 2a_{2,k}(s - s_k) + 3a_{3,k}(s - s_k)^2 + 4a_{4,k}(s - s_k)^3 + 5a_{5,k}(s - s_k)^4\Big] \\
&\quad + \frac{r'}{rR_1}\Big[b_{0,k} + b_{1,k}(s - s_k) + b_{2,k}(s - s_k)^2 + b_{3,k}(s - s_k)^3\Big]
\end{aligned}
\qquad \text{(B3)}
$$

(Equations continued on next page)

$$\left.\begin{aligned}\kappa_{12}(s) = {} & \frac{n}{r}\left[a_{1,k} + 2a_{2,k}(s - s_k) + 3a_{3,k}(s - s_k)^2 + 4a_{4,k}(s - s_k)^3 + 5a_{5,k}(s - s_k)^4\right] \\ & - \frac{nr'}{r^2}\left[a_{0,k} + a_{1,k}(s - s_k) + a_{2,k}(s - s_k)^2 + a_{3,k}(s - s_k)^3 + a_{4,k}(s - s_k)^4\right. \\ & \left. + a_{5,k}(s - s_k)^5\right] - \frac{n}{rR_1}\left[b_{0,k} + b_{1,k}(s - s_k) + b_{2,k}(s - s_k)^2 + b_{3,k}(s - s_k)^3\right] \\ & + \frac{1}{R_2}\left[c_{1,k} + 2c_{2,k}(s - s_k) + 3c_{3,k}(s - s_k)^2\right] - \frac{r'}{rR_2}\left[c_{0,k} + c_{1,k}(s - s_k)\right. \\ & \left. + c_{2,k}(s - s_k)^2 + c_{3,k}(s - s_k)^3\right]\end{aligned}\right\} \quad \text{(B3)}$$

Stress and Moment Resultants

The stress and moment resultants are computed by substituting the expressions for middle-surface strains and changes in curvatures from equations (B3) into the equations from reference 3 which are:

$$\left.\begin{aligned} T_1(s) &= c_{11}e_1(s) + c_{12}e_2(s) + K_{11}\kappa_1(s) + K_{12}\kappa_2(s) \\ T_2(s) &= c_{12}e_1(s) + c_{22}e_2(s) + K_{12}\kappa_1(s) + K_{22}\kappa_2(s) \\ T_{12}(s) &= c_{66}e_{12}(s) + K_{66}\kappa_{12}(s) \\ M_1(s) &= D_{11}\kappa_1(s) + D_{12}\kappa_2(s) + K_{11}e_1(s) + K_{12}e_2(s) \\ M_2(s) &= D_{12}\kappa_1(s) + D_{22}\kappa_2(s) + K_{12}e_1(s) + K_{22}e_2(s) \\ M_{12}(s) &= K_{66}e_{12}(s) + D_{66}\kappa_{12}(s)\end{aligned}\right\} \quad \text{(B4)}$$

where

T_1, T_2 meridional and circumferential stress resultant, respectively

T_{12} shear stress resultant

M_1, M_2 meridional and circumferential moment resultant, respectively

M_{12} twisting moment resultant

Extreme-Fiber Strains

The extreme-fiber strains are calculated by using formulas from reference 7. These formulas are as follows:

$$e_1^T(s) = \frac{1}{1 \pm \frac{h(s)}{2R_1(s)}}\left[e_1(s) \pm \frac{h(s)}{2}\kappa_1(s)\right]$$

$$e_2^T(s) = \frac{1}{1 \pm \frac{h(s)}{2R_2(s)}}\left[e_2(s) \pm \frac{h(s)}{2}\kappa_2(s)\right]$$

$$e_{12}^T(s) = \frac{1}{\left[1 \pm \frac{h(s)}{2R_1(s)}\right]\left[1 \pm \frac{h(s)}{2R_2(s)}\right]}\left(\left[1 - \frac{h^2(s)}{4R_1(s)R_2(s)}\right]e_{12}(s)\right.$$

$$\left. \pm 2\left\{1 \pm \left[\frac{1}{R_1(s)} + \frac{1}{R_2(s)}\right]\frac{h(s)}{4}\right\}\frac{h(s)}{2}\kappa_{12}(s)\right)$$

where

e_1^T total meridional strain at extreme fibers

e_2^T total circumferential strain at extreme fibers

e_{12}^T total shear strain at extreme fibers

The + in the ± denotes outer fiber and the - denotes inner fiber.

Extreme-Fiber Stresses

The extreme-fiber stresses are calculated by use of the constitutive equations for a linear orthotropic material

$$\sigma_1(s) = \frac{E_1}{1 - \nu_1\nu_2}\left[e_1^T(s) + \nu_2 e_2^T(s)\right]$$

$$\sigma_2(s) = \frac{E_2}{1 - \nu_1\nu_2}\left[e_2^T(s) + \nu_1 e_1^T(s)\right]$$

$$\sigma_{12}(s) = G_{12}e_{12}^{T}(s)$$

where

σ_1 total meridional stress in extreme fibers

σ_2 total circumferential stress in extreme fibers

σ_{12} total shear stress in extreme fibers

APPENDIX C

TREATMENT OF RING STIFFENERS

This appendix is intended to illustrate the method of treating ring stiffeners. The derivations are taken in large part from reference 8.

It should be pointed out that the treatment of rings is based on two important assumptions:

(1) The connection between a ring and the shell is represented by a single common circumference which the analyst must choose as part of the overall idealization of the stiffened shell.

(2) The rings are jointed to the shell only along circumferences which are element junctures.

The first assumption is a mathematical simplification made to expedite the analysis. The second assumption is only a limitation of the present programing.

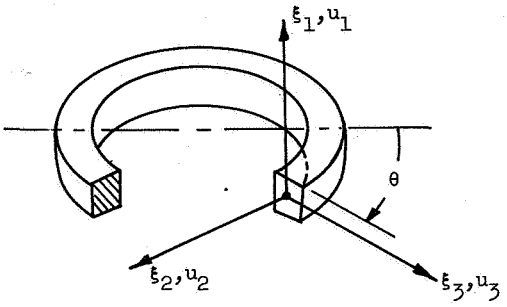
Development of Stiffness Matrix for Ring

Assumed displacement field.- For the purpose of the following derivation, the reader is referred to figure 7. In this figure, a is the distance from the axis of revolution to the origin of the ξ_1, ξ_3 axes. The ξ_1- and ξ_3-directions are parallel and perpendicular, respectively, to the axis of revolution. The variables u_1, u_2, and u_3 are displacement components in the ξ_1-, ξ_2-, and ξ_3-directions, respectively, at a general point in ring cross section. The variables U, V, and W are displacement components at the origin of the ξ_1, ξ_3 coordinate system in the ξ_1-, ξ_2-, and ξ_3-directions, respectively. The variable α is the rotation of the ring cross section about the ξ_2-direction. The twist of the cross section is given by $\Phi(\theta,t)$, and the warping function of the cross section is given by $\psi(\xi_1, \xi_3)$.

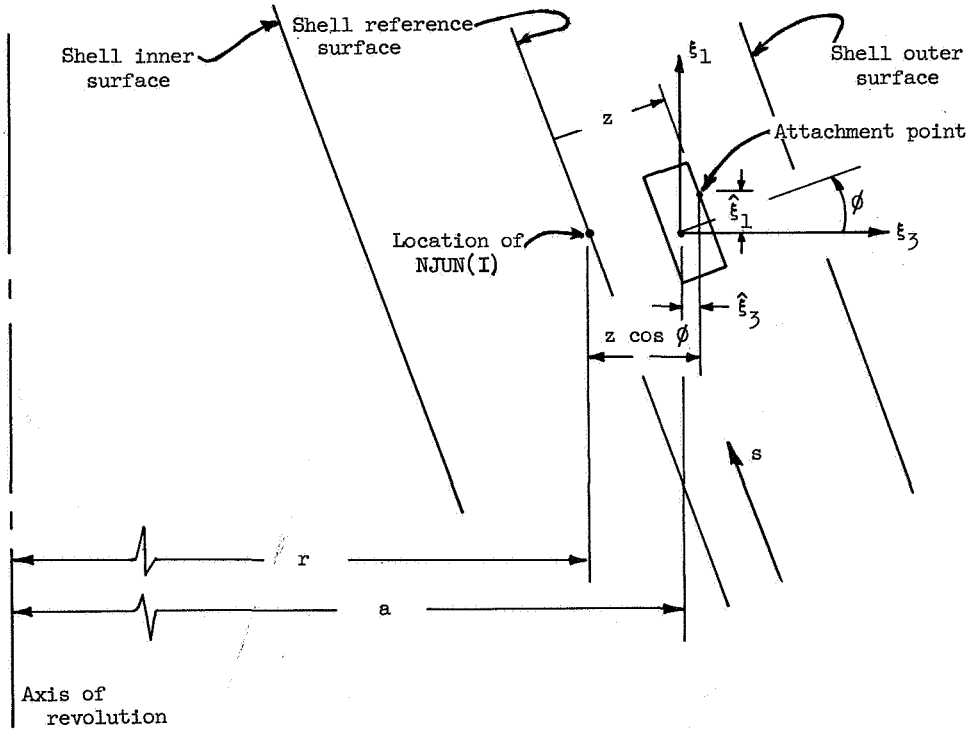
The displacements of points in the ring cross section for the purpose of deriving the stiffness matrix are taken as

$$\left.\begin{aligned} u_1(\xi_1,\theta,\xi_3,t) &= U(\theta,t) + \xi_3\alpha(\theta,t) \\ u_2(\xi_1,\theta,\xi_3,t) &= \left(1 + \frac{\xi_3}{a}\right)V(\theta,t) - \frac{\xi_3}{a}\frac{\partial W}{\partial\theta}\Phi(\theta,t) - \frac{\xi_1}{a}\frac{\partial U}{\partial\theta}(\theta,t) + \psi(\xi_1,\xi_3)\Phi(\theta,t) \\ u_3(\xi_1,\theta,\xi_3,t) &= W(\theta,t) - \xi_1\alpha(\theta,t) \end{aligned}\right\} \qquad (C1)$$

where $\Phi = \frac{1}{a^2}\frac{\partial U}{\partial\theta}(\theta,t) - \frac{1}{a}\frac{\partial\alpha}{\partial\theta}(\theta,t)$.

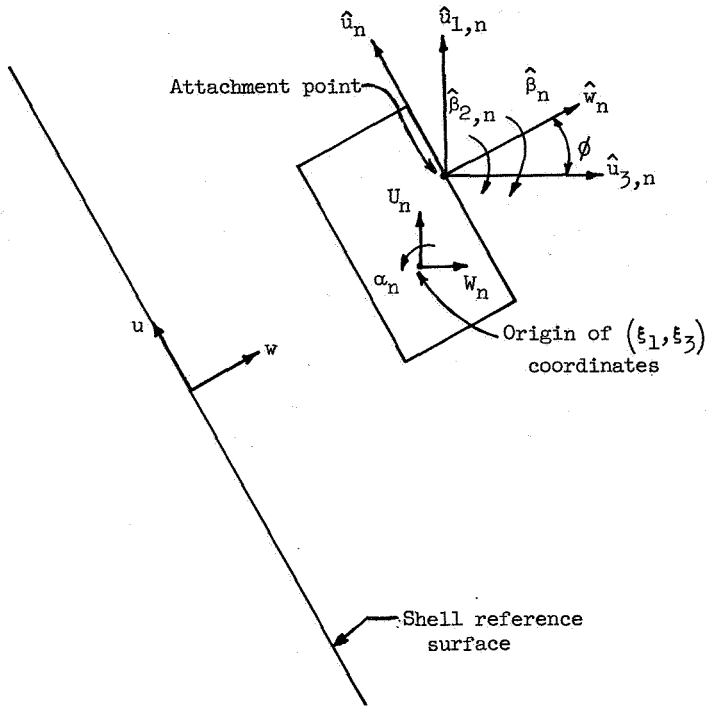


(a) Ring coordinate system.



(b) Position of typical ring in shell wall.

Figure 7.- Ring nomenclature.



(c) Relationship of displacement components of ring and shell.

Figure 7.- Concluded.

The displacements U, V, and W at the origin and the rotation α are assumed to have the form

$$\left.\begin{aligned} U(\theta,t) &= U_n \cos n\theta\, e^{i\omega t} \\ V(\theta,t) &= V_n \sin n\theta\, e^{i\omega t} \\ W(\theta,t) &= W_n \cos n\theta\, e^{i\omega t} \\ \alpha(\theta,t) &= \alpha_n \cos n\theta\, e^{i\omega t} \end{aligned}\right\} \qquad \text{(C2)}$$

In view of equations (C2), equation (C1) can be written in the form

$$\left.\begin{aligned} u_1(\xi_1,\theta,\xi_3,t) &= u_{1,n}(\xi_1,\xi_3)\cos n\theta\, e^{i\omega t} \\ u_2(\xi_1,\theta,\xi_3,t) &= u_{2,n}(\xi_1,\xi_3)\sin n\theta\, e^{i\omega t} \\ u_3(\xi_1,\theta,\xi_3,t) &= u_{3,n}(\xi_1,\xi_3)\cos n\theta\, e^{i\omega t} \end{aligned}\right\} \qquad \text{(C3)}$$

Strain-displacement relations.- The following expressions for strains are developed from the assumed displacement functions with certain approximations which are shown. The approximations are based on the assumption that ξ_3 is small compared to a.

$$\left.\begin{aligned} \epsilon_{11} &= 0 \\ \epsilon_{22} &= \frac{1}{a+\xi_3}\left(\frac{\partial u_2}{\partial \xi_2} + u_3\right) \\ &\approx \frac{1}{a}\left(\frac{\partial u_2}{\partial \xi_2} + u_3\right) \\ &= \frac{1}{a}\left[\left(1+\frac{\xi_3}{a}\right)\frac{\partial V}{\partial \xi_2} - \frac{\xi_3}{a}\frac{\partial^2 W}{\partial \xi_2^2} + \left(\frac{\psi}{a^2} - \frac{\xi_1}{a}\right)\frac{\partial^2 U}{\partial \xi_2^2} - \frac{\psi}{a}\frac{\partial^2 \alpha}{\partial \xi_2^2} + W - \xi_1\alpha\right] \\ \epsilon_{33} &= 0 \\ \epsilon_{12} &= \frac{\partial u_2}{\partial \xi_1} + \frac{1}{a+\xi_3}\frac{\partial u_1}{\partial \xi_2} \\ &= \frac{\xi_3}{a+\xi_3}\left(-\frac{1}{a}\frac{\partial U}{\partial \xi_2} + \frac{\partial \alpha}{\partial \xi_2}\right) + \frac{\partial \psi}{\partial \xi_1}\Phi \\ &\approx \left(\frac{\partial \psi}{\partial \xi_1} - \xi_3\right)\Phi \\ \epsilon_{13} &= 0 \end{aligned}\right\} \qquad \text{(C4)}$$

(Equations continued on next page)

$$\left.\begin{aligned}\epsilon_{23} &= \frac{1}{a+\xi_3}\frac{\partial u_3}{\partial \xi_2} + \frac{\partial u_2}{\partial \xi_3} - \frac{u_2}{a+\xi_3} \\ &= \frac{\partial \psi}{\partial \xi_3}\Phi + \frac{\psi}{a+\xi_3}\Phi + \frac{\xi_1}{a+\xi_3}\left(\frac{1}{a}\frac{\partial U}{\partial \xi_2} - \frac{\partial \alpha}{\partial \xi_2}\right) \\ &\approx \left(\frac{\partial \psi}{\partial \xi_3} + \frac{\psi}{a} + \xi_1\right)\Phi\end{aligned}\right\} \tag{C4}$$

Strain energy of ring.- The strain energy for the ring may be written as

$$U = \frac{1}{2}\int_0^{2\pi}\int_A \begin{bmatrix}\epsilon_{22} & \epsilon_{12} & \epsilon_{23}\end{bmatrix}\begin{bmatrix}E & 0 & 0\\ 0 & G & 0\\ 0 & 0 & G\end{bmatrix}\begin{Bmatrix}\epsilon_{22}\\ \epsilon_{12}\\ \epsilon_{23}\end{Bmatrix} a\,dA\,d\theta \tag{C5}$$

where the inner integration is carried out over the ring cross-sectional area. Substitution of equations (C1), (C2), and (C4) into equation (C5) gives the following expression for the ring strain energy:

$$U = \frac{1}{2}\begin{bmatrix}U_n & V_n & W_n & \alpha_n\end{bmatrix}\begin{bmatrix}\bar{K}\end{bmatrix}\begin{Bmatrix}U_n\\ V_n\\ W_n\\ \alpha_n\end{Bmatrix} \tag{C6}$$

where $\bar{K}$ is the ring stiffness matrix which is a symmetric 4×4 matrix. The elements are as follows:

$$\left.\begin{aligned}\bar{K}_{11} &= c_n\left(\frac{EI_3n^4}{a^3} - \frac{2E\Gamma_4n^4}{a^4} + \frac{E\Gamma_3n^4}{a^5} + \frac{GJn^2}{a^3}\right) \\ \bar{K}_{12} &= c_n\left(\frac{E\Gamma_1n^3}{a^2} - \frac{E\Gamma_6n^3}{a^3} + \frac{EI_{13}n^3}{a^3} - \frac{E\Gamma_5n^3}{a^4}\right) \\ \bar{K}_{13} &= c_n\left(\frac{EI_{13}n^4}{a^3} - \frac{E\Gamma_5n^4}{a^4} + \frac{E\Gamma_1n^2}{a^2} - \frac{E\Gamma_6n^2}{a^3}\right) \\ \bar{K}_{14} &= c_n\left(\frac{E\Gamma_4n^4}{a^3} + \frac{E\Gamma_4n^2}{a^3} - \frac{EI_3n^2}{a^2} - \frac{E\Gamma_3n^4}{a^4} - \frac{GJn^2}{a^2}\right)\end{aligned}\right\} \tag{C7}$$

(Equations continued on next page)

$$
\left.
\begin{aligned}
\bar{K}_{22} &= c_n\left(\frac{EAn^2}{a} + \frac{2E\Gamma_2 n^2}{a^2} + \frac{EI_1 n^2}{a^3}\right) \\
\bar{K}_{23} &= c_n\left(\frac{E\Gamma_2 n^3}{a^2} + \frac{EAn}{a} + \frac{EI_1 n^3}{a^3} + \frac{E\Gamma_2 n}{a^2}\right) \\
\bar{K}_{24} &= c_n\left(\frac{E\Gamma_6 n^3}{a^2} - \frac{E\Gamma_1 n}{a} + \frac{E\Gamma_5 n^3}{a^3} - \frac{EI_{13} n}{a^2}\right) \\
\bar{K}_{33} &= c_n\left(\frac{EI_1 n^4}{a^3} + \frac{2E\Gamma_2 n^2}{a^2} + \frac{EA}{a}\right) \\
\bar{K}_{34} &= c_n\left(\frac{E\Gamma_5 n^4}{a^3} - \frac{EI_{13} n^2}{a^2} + \frac{E\Gamma_6 n^2}{a^2} - \frac{E\Gamma_1}{a}\right) \\
\bar{K}_{44} &= c_n\left(\frac{E\Gamma_3 n^4}{a^3} - \frac{2E\Gamma_4 n^2}{a^2} + \frac{EI_3}{a} + \frac{GJn^2}{a}\right)
\end{aligned}
\right\} \qquad \text{(C7)}
$$

$c_n = \pi \qquad (n \neq 0)$

$c_n = 2\pi \qquad (n = 0)$

and where

$$
\left.
\begin{aligned}
EI_1 &= \int_A E\xi_3^2 dA \\
EI_3 &= \int_A E\xi_1^2 dA \\
EI_{13} &= \int_A E\xi_1\xi_3\, dA \\
E\Gamma_1 &= \int_A E\xi_1\, dA \\
E\Gamma_2 &= \int_A E\xi_3\, dA
\end{aligned}
\right\} \qquad \text{(C8)}
$$

(Equations continued on next page)

$$
\left.
\begin{aligned}
EA &= \int_A E\, dA \\
E\Gamma_3 &= \int_A E\psi^2 dA \\
E\Gamma_4 &= \int_A E\psi\xi_1\, dA \\
E\Gamma_5 &= \int_A E\psi\xi_3\, dA \\
E\Gamma_6 &= \int_A E\psi\, dA \\
GJ &= \int_A G\left[\left(\frac{\partial\psi}{\partial\xi_3} - \frac{\psi}{a} + \xi_1\right)^2 + \left(\frac{\partial\psi}{\partial\xi_1} - \xi_3\right)^2\right] dA
\end{aligned}
\right\} \qquad (C8)
$$

Development of Mass Matrix for Ring

Assumed displacement field.- For the purpose of developing the mass matrix the displacements are assumed to have the form

$$
\left.
\begin{aligned}
u_1(\xi_1,\theta,\xi_3,t) &= U(\theta,t) + \xi_3\alpha(\theta,t) \\
u_2(\xi_1,\theta,\xi_3,t) &= \left(1 + \frac{\xi_3}{a}\right)V(\theta,t) \\
u_3(\xi_1,\theta,\xi_3,t) &= W(\theta,t) - \xi_1\alpha(\theta,t)
\end{aligned}
\right\} \qquad (C9)
$$

Kinetic energy of ring.- The kinetic energy T takes the form

$$
T = \frac{1}{2}\int_0^{2\pi}\int_A \begin{bmatrix}\dot{u}_1\dot{u}_2\dot{u}_3\end{bmatrix}\begin{bmatrix}\gamma & & \\ & \gamma & \\ & & \gamma\end{bmatrix}\begin{Bmatrix}\dot{u}_1 \\ \dot{u}_2 \\ \dot{u}_3\end{Bmatrix}(a + \xi_3)\, dA\, d\theta \qquad (C10)
$$

where γ is the mass density of the ring material.

Substitution of equations (C2) into equations (C9) and (C10) yields the following expression for kinetic energy of the ring:

$$T = \frac{\omega^2}{2} \left[U_n V_n W_n \alpha_n\right] \left[\bar{M}\right] \begin{Bmatrix} U_n \\ V_n \\ W_n \\ \alpha_n \end{Bmatrix} \tag{C11}$$

where $\bar{M}$ is the mass matrix for the ring. It is a symmetric 4×4 matrix whose non-zero elements are as follows:

$$\left.\begin{aligned}
\bar{M}_{11} &= c_n\left(am_1\right) \\
\bar{M}_{14} &= c_n\left(am_1\bar{\xi}_3\right) \\
\bar{M}_{22} &= c_n\left(am_1 + 2m_1\bar{\xi}_3 + \frac{m_3}{a}\right) \\
\bar{M}_{33} &= c_n\left(am_1\right) \\
\bar{M}_{34} &= c_n\left(-am_1\bar{\xi}_1\right) \\
\bar{M}_{44} &= c_n\left(am_2 + am_3\right)
\end{aligned}\right\} \tag{C12}$$

$$c_n = \pi \qquad (n \neq 0)$$

$$c_n = 2\pi \qquad (n = 0)$$

and where

$$\left.\begin{aligned}
m_1 &= \int_A \gamma \, dA \\
m_1\bar{\xi}_3 &= \int_A \gamma\xi_3 \, dA \\
m_1\bar{\xi}_1 &= \int_A \gamma\xi_1 \, dA
\end{aligned}\right\} \tag{C13}$$

(Equations continued on next page)

$$\left.\begin{aligned} m_2 &= \int_A \gamma \xi_1^2 dA \\ m_3 &= \int_A \gamma \xi_3^2 dA \end{aligned}\right\} \tag{C13}$$

Transformation of Ring Stiffness and Mass Matrices

In order to add the stiffness and mass matrices of the ring to the stiffness and mass matrices of the shell, it is necessary to perform a transformation to relate the ring coordinates U_n, V_n, W_n, and α_n to the shell coordinates w_n, u_n, v_n, and β_n. The transformation involves three operations:

(1) Relating the ring displacements at the origin of the ring coordinate system to the displacements at the attachment point

(2) Relating the ring displacements at the attachment point to the shell displacements at the attachment point

(3) Relating the shell displacements at the attachment point to the shell displacements at the reference surface of the shell

The displacements and rotation at a general point (ξ_1, ξ_3) in the ring cross section are given by equation (C1). Along with the definition of β_2 this equation is

$$\begin{Bmatrix} u_{1,n} \\ u_{2,n} \\ u_{3,n} \\ \beta_{2,n} \end{Bmatrix} = \begin{bmatrix} 1 & 0 & 0 & \xi_3 \\ \frac{n\xi_1}{a} - \frac{n\psi}{a^2} & 1 + \frac{\xi_3}{a} & \frac{n\xi_3}{a} & \frac{n\psi}{a} \\ 0 & 0 & 1 & -\xi_1 \\ 0 & 0 & 0 & -1 \end{bmatrix} \begin{Bmatrix} U_n \\ V_n \\ W_n \\ \alpha_n \end{Bmatrix} \tag{C14}$$

where use is made of equations (C2) and (C3). Writing equation (C14) for the coordinates of the attachment point $\xi_1 = \hat{\xi}_1, \xi_3 = \hat{\xi}_3$ and inverting the resulting matrix gives

$$\begin{Bmatrix} U_n \\ V_n \\ W_n \\ \alpha_n \end{Bmatrix} = \begin{bmatrix} 1 & 0 & 0 & \hat{\xi}_3 \\ \dfrac{\dfrac{n\hat{\psi}}{a^2} - \dfrac{n\hat{\xi}_1}{a}}{1 + \dfrac{\hat{\xi}_3}{a}} & \dfrac{1}{1 + \dfrac{\hat{\xi}_3}{a}} & \dfrac{\dfrac{-n\hat{\xi}_3}{a}}{1 + \dfrac{\hat{\xi}_3}{a}} & \dfrac{n\hat{\psi}}{a} \\ 0 & 0 & 1 & -\hat{\xi}_1 \\ 0 & 0 & 0 & -1 \end{bmatrix} \begin{Bmatrix} \hat{u}_{1,n} \\ \hat{u}_{2,n} \\ \hat{u}_{3,n} \\ \hat{\beta}_{2,n} \end{Bmatrix} \tag{C15}$$

where a $\hat{}$ over a variable indicates that the variable is being evaluated at the attachment point. The ring displacements at the attachment point are related to the shell displacements at the attachment point as follows:

$$\begin{Bmatrix} \hat{u}_{1,n} \\ \hat{u}_{2,n} \\ \hat{u}_{3,n} \\ \hat{\beta}_{2,n} \end{Bmatrix} = \begin{bmatrix} \cos\phi & 0 & \sin\phi & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\phi & 0 & \cos\phi & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{Bmatrix} \hat{u}_n \\ \hat{v}_n \\ \hat{w}_n \\ \hat{\beta}_n \end{Bmatrix} \tag{C16}$$

Finally, the displacements of the shell at the attachment circumference are related to the displacements at the reference surface by the following equations:

$$\hat{u}_n = u_n - z\beta_n$$

$$\hat{v}_n = v_n + z\left(\frac{nw_n}{r} + \frac{v_n}{R_2}\right)$$

$$\hat{w}_n = w_n$$

$$\hat{\beta}_n = \beta_n$$

or in matrix form

$$\begin{Bmatrix} \hat{u}_n \\ \hat{v}_n \\ \hat{w}_n \\ \hat{\beta}_n \end{Bmatrix} = \begin{bmatrix} 0 & 1 & 0 & -z \\ \frac{zn}{r} & 0 & 1 + \frac{z}{R_2} & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{Bmatrix} w_n \\ u_n \\ v_n \\ \beta_n \end{Bmatrix} \tag{C17}$$

Using equations (C15), (C16), and (C17) it is now possible to relate the ring displacements U_n, V_n, W_n, and α_n to the shell displacements w_n, u_n, v_n, and β_n. The relation is

$$\begin{Bmatrix} U_n \\ V_n \\ W_n \\ \alpha_n \end{Bmatrix} = [TR] \begin{Bmatrix} w_n \\ u_n \\ v_n \\ \beta_n \end{Bmatrix} \tag{C18}$$

where the elements of $[TR]$ are as follows:

$$TR_{11} = \sin \phi$$

$$TR_{12} = \cos \phi$$

$$TR_{13} = 0$$

$$TR_{14} = -z \cos \phi + \hat{\xi}_3$$

$$TR_{21} = \frac{zn}{r\left(1 + \frac{\hat{\xi}_3}{a}\right)} + \frac{\frac{n\hat{\psi}}{a^2} - \frac{n\hat{\xi}_1}{a}}{1 + \frac{\hat{\xi}_3}{a}} \sin \phi - \frac{n\hat{\xi}_3}{a\left(1 + \frac{\hat{\xi}_3}{a}\right)} \cos \phi$$

$$TR_{22} = \frac{\frac{n\hat{\psi}}{a^2} - \frac{n\hat{\xi}_1}{a}}{1 + \frac{\hat{\xi}_3}{a}} \cos\phi + \frac{n\hat{\xi}_3}{a\left(1 + \frac{\hat{\xi}_3}{a}\right)} \sin\phi$$

$$TR_{23} = \frac{1 + \frac{z}{R_2}}{1 + \frac{\hat{\xi}_3}{a}}$$

$$TR_{24} = -z \frac{\frac{n\hat{\psi}}{a^2} - \frac{n\hat{\xi}_1}{a}}{1 + \frac{\hat{\xi}_3}{a}} \cos\phi + \frac{zn\hat{\xi}_3}{a\left(1 + \frac{\hat{\xi}_3}{a}\right)} \sin\phi + \frac{n\hat{\psi}}{a}$$

$$TR_{31} = \cos\phi$$

$$TR_{32} = -\sin\phi$$

$$TR_{33} = 0$$

$$TR_{34} = z \sin\phi - \hat{\xi}_1$$

$$TR_{41} = 0$$

$$TR_{42} = 0$$

$$TR_{43} = 0$$

$$TR_{44} = -1$$

Substitution of equation (C18) into equations (C6) and (C11) gives

$$U = \frac{1}{2} \left[w_n u_n v_n \beta_n\right] \left[TR\right]^T \left[\bar{K}\right] \left[TR\right] \begin{Bmatrix} w_n \\ u_n \\ v_n \\ \beta_n \end{Bmatrix} \qquad \text{(C19)}$$

and

$$T = \frac{\omega^2}{2}\left[w_n u_n v_n \beta_n\right]\left[TR\right]^T\left[\bar{M}\right]\left[TR\right]\begin{Bmatrix} w_n \\ u_n \\ v_n \\ \beta_n \end{Bmatrix} \tag{C20}$$

Thus, the transformed stiffness and mass matrices for the ring are identified as $\left[K_n\right]$ and $\left[M_n\right]$ where

$$\left.\begin{aligned} \left[K_n\right] &= \left[TR\right]^T\left[\bar{K}\right]\left[TR\right] \\ \left[M_n\right] &= \left[TR\right]^T\left[\bar{M}\right]\left[TR\right] \end{aligned}\right\} \tag{C21}$$

The matrices $\left[K_n\right]$ and $\left[M_n\right]$ are the stiffness and mass matrices to be added to the shell mass and stiffness matrices, as shown schematically in figure 8.

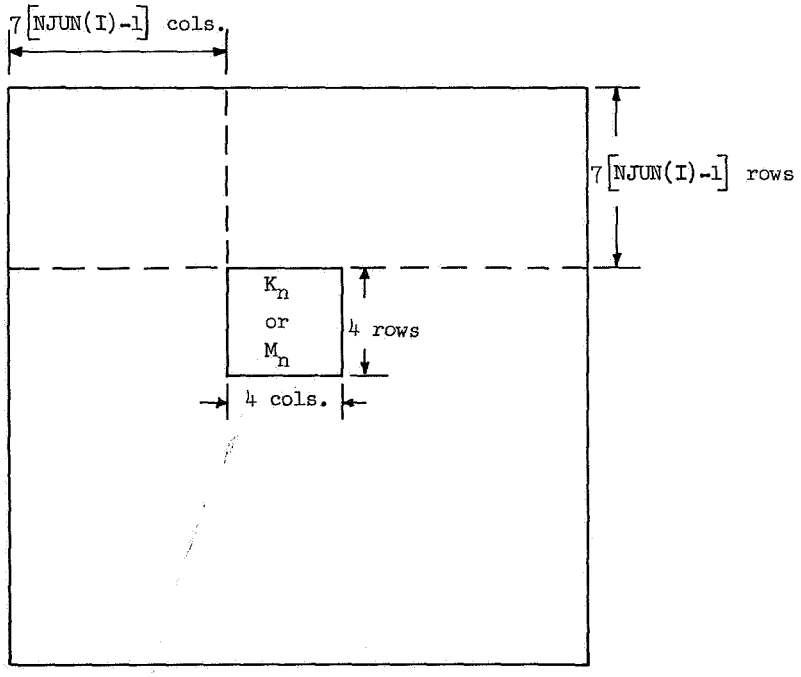


Figure 8.- Illustration of addition of Ith ring matrix to shell matrix.

Inclusion of Ring Stiffeners in Computer Program

It is now possible to describe the flow of information in the program as illustrated in the flow chart in figure 1. In BLOCK (1) the input is read, and if a ring-stiffened shell is being considered, the input control number NRING is set equal to the number of rings on the shell; this causes the reading of the ring input parameters listed in table III. A set of these parameters is read for each ring. If there are no rings on the shell being treated, NRING is set equal to zero and the read statement for the ring parameters is bypassed. In BLOCK (6) a test is made on NRING, and if NRING is zero, computing BLOCKS (7) to (11) in which the ring computations are carried out are bypassed. If NRING is nonzero then a cycle on NRING is initiated as indicated in BLOCK (7). In each pass through this cycle the following series of calculations is performed:

BLOCK (8):

Based on input data the transformation matrix given in equation (C18) is computed.

BLOCKS (9) and (10):

The stiffness and mass matrices for the ring are given in equation (C21).

The stiffness and mass matrices for the ring are added to the mass and stiffness matrices for the shell. The position at which they are added is controlled by the input parameter NJUN(I) which denotes the shell element boundary at which the Ith ring is located. Each pass through the cycle on NRING results in the adding of one ring to the shell. When the cycle on NRING is completed, the program flow continues as illustrated in figure 1.

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TABLE VI.- CODING SHEETS FOR SAMPLE CALCULATION 1

(a) Numerical input data and control numbers

PROGRAM NO._____
CODED BY_____
DIVISION_____ SECTION_____

LANGLEY RESEARCH CENTER
FORTRAN - DATA CODING FORM

DATE_____
PAGE____ OF____
JOB ORDER_____ TASK NO._____

STATEMENT NUMBER	CONTINUATION	FORTRAN STATEMENT	IDENTIFICATION AND SEQUENCING
		SAMPLE CASE 1 CLAMPED-CLAMPED CYLINDER	
14		3 3 100 10 0 0	
1		1 1 10 1 1 0	
+0.			
+.3		+.3 +.3 +.3 +.6	
+.6		+3.6 +3.6 +.6 +.6	
+.3		+.3 +.3 +.3	
+3.0	0000000	+0.8 +3.0000000+0.8 +.3 +.3 +7.3.3.1.6.0.6.2.-0.3	
+.01		+1.1.5.3.8.4.6.2+0.8	

NASA-Langley Form 67 (MAR 69)

NOTE: WRITE NUMBERS 10, LETTERS I Ø U G Z C, SYMBOLS / . , *

TABLE VI.- CODING SHEETS FOR SAMPLE CALCULATION 1 - Concluded

(b) Function input

PROGRAM NO._____

CODED BY_____

DIVISION_____SECTION_____

LANGLEY RESEARCH CENTER

FORTRAN - DATA CODING FORM

DATE_____

PAGE_____OF._____

JOB ORDER_____TASK NO._____

STATEMENT NUMBER	CONTINUATION	FORTRAN STATEMENT	IDENTIFICATION AND SEQUENCING
		R=3.0	
		RP=0.0	
		R1=0.0	
		R1P=0.0	
		R2=1./3.	
		C1.1=YØUNG1*TH/(1.-XMU1**2)	
		C1.2=XMU1*C1.1	
		C2.2=C1.1	
		C6.6=YØUNG1*TH/(2.*(1.+XMU1))	
		D1.1=YØUNG1*TH**3/(12.*(1.-XMU1**2))	
		D1.2=XMU1*D1.1	
		D2.2=D1.1	
		D6.6=YØUNG1*TH**3/(6.*(1.+XMU1))	
		K1.1=0.0	
		K1.2=0.0	
		K2.2=0.0	
		K6.6=0.0	

NASA-Langley Form 67 (MAR 69)

NOTE: WRITE NUMBERS 0, LETTERS I Ø U G Z C, SYMBOLS / . , *

TABLE VII.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 1

(a) Idealization parameters and material properties for cylinder

SAMPLE CASE 1 CLAMPED-CLAMPED CYLINDER

K	NBEG	NLAST	ININ	ICASE	NRING	IPRINT
14	3	3	100	10	0	0

NMODE	ISTRN	ISTRES	IINT	IPLOT	IPLSTS	IFUNCT
1	1	1	10	1	1	0

	EPSILON (K)	S (K)
1	3.00000000E-01	1.50000000E-01
2	3.00000000E-01	4.50000000E-01
3	3.00000000E-01	7.50000000E-01
4	3.00000000E-01	1.05000000E+00
5	6.00000000E-01	1.50000000E+00
6	6.00000000E-01	2.10000000E+00
7	3.60000000E+00	4.20000000E+00
8	3.60000000E+00	7.80000000E+00
9	6.00000000E-01	9.90000000E+00
10	6.00000000E-01	1.05000000E+01
11	3.00000000E-01	1.09500000E+01
12	3.00000000E-01	1.12500000E+01
13	3.00000000E-01	1.15500000E+01
14	3.00000000E-01	1.18500000E+01

S SUB 0 = 0.
YOUNGS MODULUS 1 = 3.000C0000E+07
YOUNGS MODULUS 2 = 3.00000000E+07
POISSONS RATIO 1 = 3.000C0000E-01
POISSONS RATIO 2 = 3.00000000E-01
RHO = 7.33160620E-04
THICKNESS = 1.000C0000E-02
G SUB 12 = 1.15384620E+07

CLAMPED-CLAMPED BOUNDARY CONDITION - FIRST 4 AND (7K+1),(7K+2),(7K+3),(7K+4) ROWS AND COLUMNS DELETED

TABLE VII.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 1 - Continued

(b) Natural frequencies of cylinder

N = 3

	EIGENVALUES	OMEGA	FREQUENCY
1	5.30639625E+07	7.28450153E+03	1.15936443E+03
2	2.57008448E+08	1.60314830E+04	2.55148977E+03
3	6.56942557E+08	2.56308909E+04	4.07928298E+03
4	1.21039355E+09	3.47907106E+04	5.53711357E+03
5	1.79048838E+09	4.23141628E+04	6.73450818E+03
6	2.28637620E+09	4.78160664E+04	7.61016332E+03
7	3.00931882E+09	5.48572586E+04	8.73080387E+03
8	3.16852059E+09	5.62896135E+04	8.95877024E+03
9	3.82962890E+09	6.18839955E+04	9.84914378E+03
10	3.88500996E+09	6.23298481E+04	9.92010342E+03
11	4.30985782E+09	6.56495074E+04	1.04484436E+04
12	4.35456707E+09	6.59891436E+04	1.05024984E+04
13	4.68519929E+09	6.84485156E+04	1.08939196E+04
14	4.74726582E+09	6.89004051E+04	1.09658401E+04
15	4.95555780E+09	7.03957229E+04	1.12038273E+04
16	5.14841035E+09	7.17524240E+04	1.14197530E+04
17	5.17544388E+09	7.19405580E+04	1.14496954E+04
18	5.87189105E+09	7.66282653E+04	1.21957672E+04
19	5.90453864E+09	7.68409959E+04	1.22296243E+04
20	7.13512917E+09	8.44696938E+04	1.34437693E+04
21	7.17441322E+09	8.47019080E+04	1.34807273E+04
22	9.11595075E+09	9.54774882E+04	1.51957142E+04
23	9.15919094E+09	9.57036621E+04	1.52317109E+04
24	1.22594545E+10	1.10722421E+05	1.76220206E+04
25	1.23087551E+10	1.10944829E+05	1.76574180E+04
26	1.67971197E+10	1.29603703E+05	2.06270699E+04
27	1.68469876E+10	1.29795946E+05	2.06576664E+04
28	1.74284109E+10	1.32016707E+05	2.10111115E+04
29	2.20867236E+10	1.48616028E+05	2.36529754E+04
30	2.42357779E+10	1.55678444E+05	2.47769939E+04
31	2.42665489E+10	1.55777241E+05	2.47927179E+04
32	2.89665162E+10	1.70195523E+05	2.70874588E+04
33	3.73540667E+10	1.93272002E+05	3.07601945E+04
34	3.73554759E+10	1.93275648E+05	3.07607747E+04
35	3.81583992E+10	1.95341750E+05	3.10896051E+04
36	4.85008645E+10	2.20229118E+05	3.50505528E+04
37	5.19597559E+10	2.27946827E+05	3.62788643E+04
38	5.91067006E+10	2.43118697E+05	3.86935423E+04
39	5.91093463E+10	2.43124138E+05	3.86944083E+04
40	6.14486953E+10	2.47888474E+05	3.94526759E+04
41	6.14707607E+10	2.47932976E+05	3.94597587E+04
42	7.77584397E+10	2.78852003E+05	4.43806747E+04
43	8.02465150E+10	2.83278158E+05	4.50851192E+04
44	9.08192584E+10	3.01362337E+05	4.79633057E+04
45	9.08228758E+10	3.01368339E+05	4.79642609E+04
46	1.02333075E+11	3.19895413E+05	5.09129362E+04
47	1.02375065E+11	3.19962601E+05	5.09236296E+04
48	1.33872084E+11	3.65817008E+05	5.82215851E+04
49	1.45516549E+11	3.81466314E+05	6.07122496E+04
50	1.45519460E+11	3.81470129E+05	6.07128567E+04
51	1.57239064E+11	3.96533812E+05	6.31103162E+04
52	1.68782111E+11	4.10831000E+05	6.53857845E+04
53	1.75552861E+11	4.18990287E+05	6.66843753E+04
54	2.33321455E+11	4.83033596E+05	7.68771846E+04
55	2.33339674E+11	4.83052455E+05	7.68801859E+04
56	2.55467024E+11	5.05437458E+05	8.04428699E+04
57	2.78674269E+11	5.27896077E+05	8.40172700E+04
58	3.11498672E+11	5.58120660E+05	8.88276619E+04
59	3.19610644E+11	5.65341174E+05	8.99768424E+04
60	3.63933329E+11	6.03269870E+05	9.60132227E+04
61	3.63940565E+11	6.03274950E+05	9.60141903E+04
62	4.98978418E+11	7.06384044E+05	1.12424512E+05
63	5.19501949E+11	7.20764836E+05	1.14713286E+05

64	5.20582872E+11	7.21514291E+05	1.14832566E+05
65	5.26438949E+11	7.25561127E+05	1.15476640E+05
66	8.01578350E+11	8.95309081E+05	1.42492866E+05
67	8.07274083E+11	8.98484327E+05	1.42998222E+05
68	8.99926332E+11	9.48644471E+05	1.50981457E+05
69	9.18984965E+11	9.58637035E+05	1.52571823E+05
70	1.15966434E+12	1.07687712E+06	1.71390317E+05
71	1.16326521E+12	1.07854773E+06	1.71656203E+05
72	1.47850191E+12	1.21593664E+06	1.93523326E+05
73	1.49471524E+12	1.22258547E+06	1.94580521E+05
74	1.67966641E+12	1.29601945E+06	2.06267901E+05
75	1.68069582E+12	1.29641653E+06	2.06331099E+05
76	2.26613636E+12	1.50536918E+06	2.39586946E+05
77	2.28050373E+12	1.51013368E+06	2.40345240E+05
78	2.44015924E+12	1.56210090E+06	2.48616081E+05
79	2.44042728E+12	1.56218670E+06	2.48629735E+05
80	3.26783722E+12	1.80771602E+06	2.87706941E+05
81	3.27343659E+12	1.81064535E+06	2.88173158E+05
82	3.53104112E+12	1.87910647E+06	2.99069083E+05
83	3.53109481E+12	1.87912075E+06	2.99071357E+05
84	4.74645767E+12	2.17863835E+06	3.46741153E+05
85	4.75118210E+12	2.17972065E+06	3.46913316E+05
86	5.10508019E+12	2.25944245E+06	3.59601435E+05
87	5.10509447E+12	2.25944561E+06	3.59601938E+05
88	5.87352887E+12	2.62174157E+06	4.17263131E+05
89	5.87506218E+12	2.62203398E+06	4.17309668E+05
90	7.04343914E+12	2.65394786E+06	4.22388917E+05
91	7.04419479E+12	2.65409020E+06	4.22411575E+05
92	1.00384610E+13	3.16835304E+06	5.04259048E+05
93	1.00398532E+13	3.16857274E+06	5.04294014E+05
94	1.44944399E+13	3.80715641E+06	6.05927761E+05
95	1.44953096E+13	3.80727049E+06	6.05945918E+05
96	1.98813495E+13	4.45885069E+06	7.09548128E+05
97	1.98815433E+13	4.45887243E+06	7.09551587E+05

TABLE VII.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION I - Continued

(c) Eigenvectors corresponding to the lowest five natural frequencies of cylinder

VECTOR	W	U	V	BETA	U PRIME	V PRIME	BETA PRIME
1	0.	0.	0.	0.	-1.62988997E+00	-1.69812582E+00	2.58516726E+02
	3.27957335E+00	-4.86434576E-01	-6.30940258E-01	9.49162587E+00	-1.60353467E+00	-2.41992655E+00	-2.74402901E+01
	5.60848323E+00	-9.36687704E-01	-1.42340359E+00	7.67403830E+00	-1.38887501E+00	-2.84507958E+00	4.97567523E+00
	8.13618084E+00	-1.32038611E+00	-2.33309576E+00	9.07476627E+00	-1.16955812E+00	-3.20618072E+00	3.61294494E+00
	1.09982128E+01	-1.63940566E+00	-3.34015945E+00	9.95546721E+00	-9.56555642E-01	-3.49661726E+00	2.44602275E+00
	1.73479856E+01	-2.08900335E+00	-5.55865416E+00	1.10845408E+01	-5.44029908E-01	-3.86345562E+00	1.42376076E+00
	2.41303262E+01	-2.29895008E+00	-7.90981487E+00	1.15402471E+01	-1.58566095E-01	-4.00731216E+00	-1.00814338E+00
	4.95268404E+01	9.96159051E-13	-1.66582777E+01	-6.02770381E-12	1.08637646E+00	1.92632036E-12	-5.24787151E+00
	2.41303262E+01	2.29895008E+00	-7.90981487E+00	-1.15402471E+01	-1.58566095E-01	4.00731216E+00	-1.00814338E+00
	1.73479856E+01	2.08900335E+00	-5.55865416E+00	-1.10845408E+01	-5.44029908E-01	3.86345562E+00	1.42376076E+00
	1.09982128E+01	1.63940566E+00	-3.34015945E+00	-9.95546721E+00	-9.56555642E-01	3.49661726E+00	2.44602275E+00
	8.13618084E+00	1.32038611E+00	-2.33309576E+00	-9.07476627E+00	-1.16955812E+00	3.20618072E+00	3.61294494E+00
	5.60848323E+00	9.36687704E-01	-1.42340359E+00	-7.67403830E+00	-1.38887501E+00	2.84507958E+00	4.97567523E+00
	3.27957335E+00	4.86434576E-01	-6.30940258E-01	-9.49162587E+00	-1.60353467E+00	2.41992655E+00	-2.74402901E+01
	0.	0.	0.	0.	-1.62988997E+00	1.69812582E+00	2.58516726E+02
2	0.	0.	0.	0.	-2.30703667E+00	-5.44342817E+00	5.06267493E+02
	7.32971422E+00	-6.36522050E-01	-1.80985365E+00	2.40052189E+01	-1.95880129E+00	-6.44916744E+00	-5.00925675E+01
	1.33552142E+01	-1.13422022E+00	-3.80144422E+00	1.89461695E+01	-1.34457771E+00	-6.76630917E+00	2.62778365E+00
	1.91796708E+01	-1.44503444E+00	-5.84598561E+00	1.96872130E+01	-7.33017930E-01	-6.81558203E+00	2.83794703E-01
	2.50259830E+01	-1.57876358E+00	-7.86427466E+00	1.91070832E+01	-1.59755584E-01	-6.60514484E+00	-4.57057123E+00
	3.55997582E+01	-1.36688472E+00	-1.15106387E+01	1.60006947E+01	8.52373874E-01	-5.45504685E+00	-1.06513928E+00
	4.33867041E+01	-6.21964760E-01	-1.41980311E+01	1.12589992E+01	1.70570775E+00	-3.77349289E+00	-1.87910173E+01
	-1.26816700E-11	4.92778565E+00	5.10085725E-12	-2.64827241E+01	-7.77793165E-13	9.16951440E+00	-4.40546412E-11
	-4.33867041E+01	-6.21964760E-01	1.41980311E+01	1.12589992E+01	-1.70570775E+00	-3.77349289E+00	1.87910173E+01
	-3.55997582E+01	-1.36688472E+00	1.15106387E+01	1.60006947E+01	-8.52373874E-01	-5.45504685E+00	1.06513927E+00
	-2.50259830E+01	-1.57876358E+00	7.86427466E+00	1.91070832E+01	1.59755584E-01	-6.60514484E+00	4.57057123E+00
	-1.91796708E+01	-1.44503444E+00	5.84598561E+00	1.96872130E+01	7.33017930E-01	-6.81558203E+00	-2.83794703E-01
	-1.33552142E+01	-1.13422022E+00	3.80144422E+00	1.89461695E+01	1.34457771E+00	-6.76630917E+00	-2.62778365E+00
	-7.32971422E+00	-6.36522050E-01	1.80985365E+00	2.40052189E+01	1.95880129E+00	-6.44916744E+00	5.00925675E+01
	0.	0.	0.	0.	2.30703667E+00	-5.44342817E+00	-5.06267493E+02
3	0.	0.	0.	0.	-2.10056620E+00	-9.46798849E+00	6.98541632E+02
	1.13370002E+01	-5.11650850E-01	-3.00202928E+00	4.03434321E+01	-1.39782606E+00	-1.02881768E+01	-6.62304184E+01
	2.14681929E+01	-7.94875640E-01	-6.04844055E+00	3.03911175E+01	-4.77063853E-01	-9.88153839E+00	-9.36426831E+00
	3.02164011E+01	-8.03351041E-01	-8.87042037E+00	2.76361310E+01	4.01271827E-01	-8.82081666E+00	-1.29852690E+01
	3.77905309E+01	-5.68446446E-01	-1.12851458E+01	2.25293793E+01	1.15371153E+00	-7.18263471E+00	-2.03382635E+01
	4.71217322E+01	4.54393932E-01	-1.42879566E+01	8.33791478E+00	2.20574913E+00	-2.57882167E+00	-1.91966479E+01
	4.65212042E+01	1.87511591E+00	-1.42486526E+01	-9.34675188E+00	2.81425270E+00	2.79200566E+00	-2.81937996E+01
	-4.43782327E+01	-3.36527466E-13	1.39152797E+01	7.24775973E-12	-3.80270493E+00	-1.64523182E-12	3.29845227E+01
	4.65212042E+01	-1.87511591E+00	-1.42486526E+01	9.34675188E+00	2.81425270E+00	-2.79200566E+00	-2.81937996E+01
	4.71217322E+01	-4.54393932E-01	-1.42879566E+01	-8.33791478E+00	2.20574913E+00	2.57882167E+00	-1.91966479E+01
	3.77905309E+01	5.68446446E-01	-1.12851458E+01	-2.25293793E+01	1.15371153E+00	7.18263471E+00	-2.03382635E+01
	3.02164011E+01	8.03351041E-01	-8.87042037E+00	-2.76361310E+01	4.01271827E-01	8.82081666E+00	-1.29852690E+01
	2.14681929E+01	7.94875640E-01	-6.04844055E+00	-3.03911175E+01	-4.77063853E-01	9.88153839E+00	-9.36426831E+00
	1.13370002E+01	5.11650850E-01	-3.00202928E+00	-4.03434321E+01	-1.39782606E+00	1.02881768E+01	-6.62304184E+01
	0.	0.	0.	0.	-2.10056620E+00	9.46798849E+00	6.98541632E+02

4	0.	0.	0.	0.	-1.41005023E+00	-1.26543801E+01	8.46478144E+02
	1.52501939E+01	-2.63645409E-01	-3.89741862E+00	5.78050266E+01	-5.25041067E-01	-1.29637934E+01	-7.86514744E+01
	2.95654567E+01	-2.79171253E-01	-7.57124372E+00	4.04164862E+01	4.29362568E-01	-1.12684697E+01	-3.47287847E+01
	4.02037312E+01	-1.62280885E-02	-1.05432825E+01	3.00906738E+01	1.28203465E+00	-8.34596245E+00	-4.11149113E+01
	4.72401777E+01	4.64077632E-01	-1.24990497E+01	1.65013356E+01	1.87535839E+00	-4.47495189E+00	-4.01378436E+01
	4.75075309E+01	1.73761775E+00	-1.26288797E+01	-1.69527182E+01	2.21011483E+00	4.60065361E+00	-8.68267525E+01
	2.81841984E+01	2.83238500E+00	-7.68883747E+00	-5.75497754E+01	1.63322749E+00	1.43850134E+01	4.30737841E+01
	-3.04710471E-12	-2.31712195E+00	-1.08540076E-12	5.50976053E+01	4.44419826E-13	-1.83535268E+01	9.67681874E-11
	-2.81841984E+01	2.83238500E+00	7.68883747E+00	-5.75497754E+01	-1.63322749E+00	1.43850134E+01	-4.30737841E+01
	-4.75075309E+01	1.73761775E+00	1.26288797E+01	-1.69527182E+01	-2.21011483E+00	4.60065361E+00	8.68267525E+01
	-4.72401777E+01	4.64077632E-01	1.24990497E+01	1.65013356E+01	-1.87535839E+00	-4.47495189E+00	4.01378436E+01
	-4.02037312E+01	-1.62280885E-02	1.05432825E+01	3.00906738E+01	-1.28203465E+00	-8.34596245E+00	4.11149113E+01
	-2.95654567E+01	-2.79171253E-01	7.57124372E+00	4.04164862E+01	-4.29362568E-01	-1.12684697E+01	3.47287847E+01
	-1.52501939E+01	-2.63645409E-01	3.89741862E+00	5.78050266E+01	5.25041067E-01	-1.29637934E+01	7.86514744E+01
	0.	0.	0.	0.	1.41005023E+00	-1.26543801E+01	-8.46478144E+02
5	0.	0.	0.	0.	-7.57775892E-01	-1.47080262E+01	8.95302749E+02
	1.94548471E+01	-6.34832498E-02	-4.44588990E+00	7.69462015E+01	5.27421902E-02	-1.44201575E+01	-9.36057181E+01
	3.80073669E+01	5.61772200E-02	-9.33333165E+00	4.83705394E+01	7.52167015E-01	-1.10847597E+01	-7.77252909E+01
	4.91359841E+01	3.78361405E-01	-1.09184009E+01	2.53875747E+01	1.33384723E+00	-5.88392591E+00	-8.39293927E+01
	5.28077905E+01	8.26568732E-01	-1.17814335E+01	-1.29599970E+00	1.54779186E+00	3.75094662E-01	-9.47060603E+01
	3.62296950E+01	1.68496102E+00	-9.03573911E+00	-5.31622351E+01	9.12360827E-01	1.24109827E+01	-1.01900955E+02
	-4.09227469E+00	1.88077605E+00	9.32003636E-01	-9.01745133E+01	-1.19658459E+00	2.16792207E+01	9.96166056E+01
	3.97722613E+01	-7.38087421E-13	-9.16903979E+00	3.89563911E-14	2.44712426E+00	-8.00721883E-13	-6.05372700E+01
	-4.09227469E+00	-1.88077605E+00	9.32003636E-01	9.01745133E+01	-1.19658459E+00	-2.16792207E+01	9.96166056E+01
	3.62296950E+01	-1.68496102E+00	-9.03573911E+00	5.31622351E+01	9.12360827E-01	-1.24109827E+01	-1.01900955E+02
	5.28077905E+01	-8.26568732E-01	-1.17814335E+01	1.29599970E+00	1.54779186E+00	-3.75094662E-01	-8.47060603E+01
	4.91359841E+01	-3.78361405E-01	-1.09184009E+01	-2.53875747E+01	1.33384723E+00	5.88392591E+00	-9.39293927E+01
	3.80073669E+01	-5.61772200E-02	-9.33333165E+00	-4.83705394E+01	7.52167015E-01	1.10847597E+01	-7.77252909E+01
	1.94548471E+01	6.34832498E-02	-4.44588990E+00	-7.69462015E+01	5.27421902E-02	1.44201575E+01	-9.36057181E+01
	0.	0.	0.	0.	-7.57775892E-01	1.47080262E+01	8.95302749E+02

TABLE VII.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 1 - Continued

(d) Mode shape corresponding to the lowest frequency of cylinder

MODE SHAPE CORRESPONDING TO FREQUENCY 1

X	W	U	V
0.	9.32587341E-15	-3.63771513E-15	-3.95516953E-15
3.00000000E-02	1.02397227E-01	-4.88969508E-02	-5.23483831E-02
6.00000000E-02	3.59918326E-01	-9.77830380E-02	-1.07517724E-01
9.00000000E-02	7.10780447E-01	-1.46641211E-01	-1.65345633E-01
1.20000000E-01	1.10850100E+00	-1.95454419E-01	-2.25569722E-01
1.50000000E-01	1.51981795E+00	-2.44205612E-01	-2.88327602E-01
1.80000000E-01	1.92261012E+00	-2.92877739E-01	-3.53156884E-01
2.10000000E-01	2.30381745E+00	-3.41453749E-01	-4.19995180E-01
2.40000000E-01	2.65736135E+00	-3.89916593E-01	-4.88680100E-01
2.70000000E-01	2.98206494E+00	-4.38249218E-01	-5.59049256E-01
3.00000000E-01	3.27957335E+00	-4.86434576E-01	-6.30940258E-01
3.30000000E-01	3.55287845E+00	-5.34457594E-01	-7.04251732E-01
3.60000000E-01	3.80675751E+00	-5.81503433E-01	-7.78968861E-01
3.90000000E-01	4.04604132E+00	-6.28155393E-01	-8.55059095E-01
4.20000000E-01	4.27506284E+00	-6.74196775E-01	-9.32489887E-01
4.50000000E-01	4.49763684E+00	-7.19610877E-01	-1.01122869E+00
4.80000000E-01	4.71703968E+00	-7.64381001E-01	-1.09124295E+00
5.10000000E-01	4.93598893E+00	-8.08490446E-01	-1.17250011E+00
5.40000000E-01	5.15662311E+00	-8.51922511E-01	-1.25496764E+00
5.70000000E-01	5.38048138E+00	-8.94660498E-01	-1.33861299E+00
6.00000000E-01	5.60848323E+00	-9.36687704E-01	-1.42340359E+00
6.30000000E-01	5.84099917E+00	-9.78023089E-01	-1.50935372E+00
6.60000000E-01	6.07825974E+00	-1.01869729E+00	-1.59648330E+00
6.90000000E-01	6.32036128E+00	-1.05871111E+00	-1.68476829E+00
7.20000000E-01	6.56724833E+00	-1.09806538E+00	-1.77418467E+00
7.50000000E-01	6.81875065E+00	-1.13676092E+00	-1.86470839E+00
7.80000000E-01	7.07462045E+00	-1.17479853E+00	-1.95631540E+00
8.10000000E-01	7.33456941E+00	-1.21217904E+00	-2.04898158E+00
8.40000000E-01	7.59830589E+00	-1.24890326E+00	-2.14268319E+00
8.70000000E-01	7.86557202E+00	-1.28497202E+00	-2.23739590E+00
9.00000000E-01	8.13618094E+00	-1.32038611E+00	-2.33309576E+00
9.30000000E-01	8.41001339E+00	-1.35515547E+00	-2.42976286E+00
9.60000000E-01	8.68689661E+00	-1.38929263E+00	-2.52738019E+00
9.90000000E-01	8.96667119E+00	-1.42279339E+00	-2.62592802E+00
1.02000000E+00	9.24921509E+00	-1.45565753E+00	-2.72538661E+00
1.05000000E+00	9.53443439E+00	-1.48788385E+00	-2.82573623E+00
1.08000000E+00	9.82225444E+00	-1.51947114E+00	-2.92695717E+00
1.11000000E+00	1.01126106E+01	-1.55041817E+00	-3.02902969E+00
1.14000000E+00	1.04054395E+01	-1.58072374E+00	-3.13193406E+00
1.17000000E+00	1.07006697E+01	-1.61038664E+00	-3.23565056E+00
1.20000000E+00	1.09982128E+01	-1.63940566E+00	-3.34015945E+00
1.26000000E+00	1.15999250E+01	-1.69554523E+00	-3.55135024E+00
1.32000000E+00	1.22102633E+01	-1.74918192E+00	-3.76524476E+00
1.38000000E+00	1.28288860E+01	-1.80032263E+00	-3.98171733E+00
1.44000000E+00	1.34553207E+01	-1.84897433E+00	-4.20064228E+00
1.50000000E+00	1.40890161E+01	-1.89514393E+00	-4.42189393E+00
1.56000000E+00	1.47293922E+01	-1.93883838E+00	-4.64534661E+00
1.62000000E+00	1.53758922E+01	-1.98006461E+00	-4.87087465E+00
1.68000000E+00	1.60280334E+01	-2.01882956E+00	-5.09835237E+00
1.74000000E+00	1.66854583E+01	-2.05514016E+00	-5.32765409E+00
1.80000000E+00	1.73479856E+01	-2.08900335E+00	-5.55865416E+00
1.86000000E+00	1.80146954E+01	-2.12046545E+00	-5.79058311E+00
1.92000000E+00	1.86841234E+01	-2.14957484E+00	-6.02284387E+00
1.98000000E+00	1.93541575E+01	-2.17634148E+00	-6.25556926E+00
2.04000000E+00	2.00253331E+01	-2.20077538E+00	-6.48889211E+00
2.10000000E+00	2.06987713E+01	-2.22288650E+00	-6.72294527E+00
2.16000000E+00	2.13759170E+01	-2.24268484E+00	-6.95786157E+00
2.22000000E+00	2.20579765E+01	-2.26019039E+00	-7.19377384E+00
2.28000000E+00	2.27453561E+01	-2.27539312E+00	-7.43091493E+00
2.34000000E+00	2.34370995E+01	-2.28830302E+00	-7.66911766E+00
2.40000000E+00	2.41303262E+01	-2.29895008E+00	-7.90831487E+00
2.76000000E+00	2.82097607E+01	-2.31606075E+00	-9.32233205E+00
3.12000000E+00	3.21001042E+01	-2.25830750E+00	-1.06653265E+01
3.48000000E+00	3.57428624E+01	-2.13313382E+00	-1.19193684E+01
3.84000000E+00	3.90797728E+01	-1.94806322E+00	-1.30660164E+01
4.20000000E+00	4.20531293E+01	-1.71059919E+00	-1.40868368E+01

4.56000000E+00	4.46061079E+01	-1.42824523E+00	-1.49633939E+01
4.92000000E+00	4.66830918E+01	-1.10850483E+00	-1.56772522E+01
5.28000000E+00	4.82299962E+01	-7.58881495E-01	-1.62099760E+01
5.64000000E+00	4.91945939E+01	-3.86878719E-01	-1.65431297E+01
6.00000000E+00	4.95268404E+01	9.05053810E-13	-1.66582777E+01
6.36000000E+00	4.91945939E+01	3.86878719E-01	-1.65431297E+01
6.72000000E+00	4.82299962E+01	7.58881495E-01	-1.62099760E+01
7.08000000E+00	4.66830918E+01	1.10850483E+00	-1.56772522E+01
7.44000000E+00	4.46061079E+01	1.42824523E+00	-1.49633939E+01
7.80000000E+00	4.20531293E+01	1.71059919E+00	-1.40868368E+01
8.16000000E+00	3.90797728E+01	1.94806322E+00	-1.30660164E+01
8.52000000E+00	3.57428624E+01	2.13313382E+00	-1.19193684E+01
8.88000000E+00	3.21001042E+01	2.25830750E+00	-1.06653285E+01
9.24000000E+00	2.82097607E+01	2.31608075E+00	-9.32233205E+00
9.60000000E+00	2.41303262E+01	2.29895008E+00	-7.90881487E+00
9.66000000E+00	2.34370995E+01	2.28830302E+00	-7.66911766E+00
9.72000000E+00	2.27453561E+01	2.27533312E+00	-7.43081493E+00
9.78000000E+00	2.20579765E+01	2.26018039E+00	-7.19377384E+00
9.84000000E+00	2.13759170E+01	2.24268484E+00	-6.95786157E+00
9.90000000E+00	2.06987713E+01	2.22288650E+00	-6.72294527E+00
9.96000000E+00	2.00253331E+01	2.20077538E+00	-6.48889211E+00
1.00200000E+01	1.93541575E+01	2.17634148E+00	-6.25556926E+00
1.00800000E+01	1.86841234E+01	2.14957484E+00	-6.02284387E+00
1.01400000E+01	1.80149954E+01	2.12046545E+00	-5.79058311E+00
1.02000000E+01	1.73479856E+01	2.08900335E+00	-5.55865416E+00
1.02600000E+01	1.66854583E+01	2.05514016E+00	-5.32765409E+00
1.03200000E+01	1.60280334E+01	2.01882956E+00	-5.09835237E+00
1.03800000E+01	1.53758922E+01	1.98006461E+00	-4.87087465E+00
1.04400000E+01	1.47293922E+01	1.93883838E+00	-4.64534661E+00
1.05000000E+01	1.40890161E+01	1.89514393E+00	-4.42189393E+00
1.05600000E+01	1.34553207E+01	1.84897433E+00	-4.20064228E+00
1.06200000E+01	1.28288860E+01	1.80032263E+00	-3.98171733E+00
1.06800000E+01	1.22102633E+01	1.74918192E+00	-3.76524476E+00
1.07400000E+01	1.15999250E+01	1.69554523E+00	-3.55135024E+00
1.08000000E+01	1.09982128E+01	1.63940566E+00	-3.34015945E+00
1.08300000E+01	1.07006697E+01	1.61038664E+00	-3.23565056E+00
1.08600000E+01	1.04054395E+01	1.58072374E+00	-3.13193406E+00
1.08900000E+01	1.01126106E+01	1.55041817E+00	-3.02902969E+00
1.09200000E+01	9.82225444E+00	1.51947114E+00	-2.92695717E+00
1.09500000E+01	9.53443439E+00	1.48788385E+00	-2.82573623E+00
1.09800000E+01	9.24921508E+00	1.45565753E+00	-2.72538661E+00
1.10100000E+01	8.96667119E+00	1.42279339E+00	-2.62592802E+00
1.10400000E+01	8.68689661E+00	1.38929263E+00	-2.52738019E+00
1.10700000E+01	8.41001339E+00	1.35515547E+00	-2.42976286E+00
1.11000000E+01	8.13618084E+00	1.32038611E+00	-2.33309576E+00
1.11300000E+01	7.86557202E+00	1.28497202E+00	-2.23739590E+00
1.11600000E+01	7.59830589E+00	1.24890326E+00	-2.14268319E+00
1.11900000E+01	7.33456941E+00	1.21217904E+00	-2.04898168E+00
1.12200000E+01	7.07462045E+00	1.17479853E+00	-1.95631540E+00
1.12500000E+01	6.81875066E+00	1.13676092E+00	-1.86470838E+00
1.12800000E+01	6.56724833E+00	1.09806538E+00	-1.77418467E+00
1.13100000E+01	6.32036128E+00	1.05871111E+00	-1.68476829E+00
1.13400000E+01	6.07825974E+00	1.01869729E+00	-1.59648330E+00
1.13700000E+01	5.84099917E+00	9.78023089E-01	-1.50935372E+00
1.14000000E+01	5.60848323E+00	9.36687704E-01	-1.42340359E+00
1.14300000E+01	5.38048138E+00	8.94660498E-01	-1.33861299E+00
1.14600000E+01	5.15662311E+00	8.51922511E-01	-1.25496764E+00
1.14900000E+01	4.93598893E+00	8.08490446E-01	-1.17250011E+00
1.15200000E+01	4.71703968E+00	7.64381001E-01	-1.09124295E+00
1.15500000E+01	4.49763684E+00	7.19610877E-01	-1.01122869E+00
1.15800000E+01	4.27506284E+00	6.74196775E-01	-9.32489887E-01
1.16100000E+01	4.04604132E+00	6.28155393E-01	-8.55059095E-01
1.16400000E+01	3.80675751E+00	5.81503433E-01	-7.78968861E-01
1.16700000E+01	3.55287845E+00	5.34257594E-01	-7.04251732E-01
1.17000000E+01	3.27957335E+00	4.86434576E-01	-6.30940258E-01
1.17300000E+01	2.98206494E+00	4.38249218E-01	-5.59049256E-01
1.17600000E+01	2.65736135E+00	3.89916593E-01	-4.88680100E-01
1.17900000E+01	2.30381745E+00	3.41453749E-01	-4.19995180E-01
1.18200000E+01	1.92261012E+00	2.92877739E-01	-3.53156884E-01
1.18500000E+01	1.51981795E+00	2.44205612E-01	-2.88327602E-01
1.18800000E+01	1.10850100E+00	1.95454419E-01	-2.25669722E-01
1.19100000E+01	7.10780447E-01	1.46641211E-01	-1.65345633E-01
1.19400000E+01	3.59918326E-01	9.77830380E-02	-1.07517724E-01
1.19700000E+01	1.02397227E-01	4.88969508E-02	-5.23483831E-02
1.20000000E+01	1.19904087E-14	4.10579556E-13	-4.26936264E-13

TABLE VII.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 1 - Continued

(e) Middle-surface strains and changes in curvature corresponding to the lowest frequency of cylinder

MIDDLE SURFACE STRAINS AND CHANGES IN CURVATURE CORRESPONDING TO FREQUENCY 1

X	E1	E2	E12	X1	X2	X12
0.	-1.62988997E+00	-4.28361050E-15	-1.69612582E+00	-2.58516726E+02	-5.37532981E-15	-5.65375274E-01
3.00000000E-02	-1.62981202E+00	-1.82159741E-02	-1.74396727E+00	-1.70750602E+02	8.49477659E-02	5.79022234E+00
6.00000000E-02	-1.62916573E+00	1.24550519E-02	-1.78640662E+00	-1.02295555E+02	3.24079085E-01	9.81008367E+00
9.00000000E-02	-1.62795108E+00	7.15811829E-02	-1.82346092E+00	-5.08407990E+01	6.55665236E-01	1.20388792E+01
1.20000000E-01	-1.62616807E+00	1.43830611E-01	-1.85514723E+00	-1.40755492E+01	1.03327776E+00	1.29519560E+01
1.50000000E-01	-1.62381672E+00	2.18278382E-01	-1.88148259E+00	1.03109796E+01	1.42370875E+00	1.29553374E+01
1.80000000E-01	-1.62089701E+00	2.87713154E-01	-1.90248405E+00	2.46295726E+01	1.80489115E+00	1.23857232E+01
2.10000000E-01	-1.61740896E+00	3.47943971E-01	-1.91816867E+00	3.11910149E+01	2.16381906E+00	1.15104898E+01
2.40000000E-01	-1.61335255E+00	3.97107017E-01	-1.92855350E+00	3.23060919E+01	2.49446798E+00	1.05276899E+01
2.70000000E-01	-1.60872778E+00	4.34972390E-01	-1.93365558E+00	3.02855885E+01	2.79571518E+00	9.56605262E+00
3.00000000E-01	-1.60353467E+00	4.62250859E-01	-1.93349198E+00	2.74402901E+01	3.06925993E+00	8.68498368E+00
3.30000000E-01	-1.58457372E+00	4.80041084E-01	-1.93306661E+00	2.15402655E+01	3.31812787E+00	7.93577444E+00
3.60000000E-01	-1.56556610E+00	4.89950309E-01	-1.93213345E+00	1.61708426E+01	3.54710122E+00	7.35602496E+00
3.90000000E-01	-1.54498181E+00	4.93621346E-01	-1.93070921E+00	1.13545813E+01	3.76102163E+00	6.92947880E+00
4.20000000E-01	-1.52435085E+00	4.92531059E-01	-1.92881058E+00	7.11404182E+00	3.96423288E+00	6.63920271E+00
4.50000000E-01	-1.50316322E+00	4.87983594E-01	-1.92645426E+00	3.47178412E+00	4.16056061E+00	6.46758663E+00
4.80000000E-01	-1.48141892E+00	4.81103614E-01	-1.92365696E+00	4.50368277E-01	4.35329203E+00	6.39634370E+00
5.10000000E-01	-1.45911795E+00	4.72829528E-01	-1.92043537E+00	-1.92764564E+00	4.54515556E+00	6.40651028E+00
5.40000000E-01	-1.43626031E+00	4.63906726E-01	-1.91680619E+00	-3.63969757E+00	4.73830056E+00	6.47844591E+00
5.70000000E-01	-1.41284599E+00	4.54880808E-01	-1.91278613E+00	-4.66322746E+00	4.93427705E+00	6.59183331E+00
6.00000000E-01	-1.38887501E+00	4.46090817E-01	-1.90839188E+00	-4.97567523E+00	5.13401537E+00	6.72567844E+00
6.30000000E-01	-1.36682182E+00	4.37666006E-01	-1.90677222E+00	-5.28929459E+00	5.33788127E+00	6.86699093E+00
6.60000000E-01	-1.34479584E+00	4.29603280E-01	-1.90501250E+00	-5.39293364E+00	5.54609864E+00	7.01472625E+00
6.90000000E-01	-1.32279709E+00	4.22018801E-01	-1.90311190E+00	-5.32784397E+00	5.75877185E+00	7.16320376E+00
7.20000000E-01	-1.30082557E+00	4.14898110E-01	-1.90106962E+00	-5.13527716E+00	5.97585344E+00	7.30798037E+00
7.50000000E-01	-1.27888127E+00	4.08208505E-01	-1.89888482E+00	-4.85648480E+00	6.19718120E+00	7.44585056E+00
7.80000000E-01	-1.25696419E+00	4.01891418E-01	-1.89655670E+00	-4.53271845E+00	6.42251532E+00	7.57484631E+00
8.10000000E-01	-1.23507434E+00	3.95874788E-01	-1.89408443E+00	-4.20522971E+00	6.65157552E+00	7.69423720E+00
8.40000000E-01	-1.21321171E+00	3.90085436E-01	-1.89146721E+00	-3.91527016E+00	6.88407816E+00	7.80453031E+00
8.70000000E-01	-1.19137631E+00	3.84461443E-01	-1.88870420E+00	-3.70409137E+00	7.11977339E+00	7.90747030E+00
9.00000000E-01	-1.16956812E+00	3.78964525E-01	-1.88579461E+00	-3.61294494E+00	7.35848225E+00	8.00603936E+00
9.30000000E-01	-1.14844863E+00	3.73574932E-01	-1.88302711E+00	-3.38535465E+00	7.60009243E+00	8.10020514E+00
9.60000000E-01	-1.12728875E+00	3.68252008E-01	-1.88023621E+00	-3.20918104E+00	7.84443654E+00	8.18855877E+00
9.90000000E-01	-1.10608848E+00	3.62962380E-01	-1.87742310E+00	-3.07438435E+00	8.09136186E+00	8.27249214E+00
1.02000000E+00	-1.08484782E+00	3.57685085E-01	-1.87458901E+00	-2.97092484E+00	8.34075288E+00	8.35309597E+00
1.05000000E+00	-1.06356677E+00	3.52408563E-01	-1.87173515E+00	-2.88876276E+00	8.59252231E+00	8.43115977E+00
1.08000000E+00	-1.04224532E+00	3.47127641E-01	-1.86886272E+00	-2.81785837E+00	8.84660205E+00	8.50717187E+00
1.11000000E+00	-1.02088349E+00	3.41840525E-01	-1.86597294E+00	-2.74817192E+00	9.10293408E+00	8.58131942E+00
1.14000000E+00	-9.99481264E-01	3.36545787E-01	-1.86306701E+00	-2.66966367E+00	9.36146152E+00	8.65348834E+00
1.17000000E+00	-9.78038648E-01	3.31239351E-01	-1.86014617E+00	-2.57229386E+00	9.62211954E+00	8.72326339E+00
1.20000000E+00	-9.56555642E-01	3.25911483E-01	-1.85721160E+00	-2.44602275E+00	9.88482632E+00	8.78992812E+00
1.26000000E+00	-9.14782891E-01	3.15291417E-01	-1.84718141E+00	-2.40035150E+00	1.04161416E+01	8.92023730E+00
1.32000000E+00	-8.73125735E-01	3.04843003E-01	-1.83755956E+00	-2.30423237E+00	1.09551817E+01	9.04691994E+00
1.38000000E+00	-8.31584174E-01	2.94577990E-01	-1.82833909E+00	-2.17187039E+00	1.15016468E+01	9.16737530E+00
1.44000000E+00	-7.90158209E-01	2.84466640E-01	-1.81951309E+00	-2.01747062E+00	1.20551067E+01	9.27985498E+00
1.50000000E+00	-7.48847838E-01	2.74444767E-01	-1.81107460E+00	-1.85523809E+00	1.26150514E+01	9.38346285E+00
1.56000000E+00	-7.07653062E-01	2.64450787E-01	-1.80301671E+00	-1.69937786E+00	1.31809433E+01	9.47815511E+00
1.62000000E+00	-6.66573881E-01	2.54422762E-01	-1.79533246E+00	-1.56409497E+00	1.37522673E+01	9.56474023E+00
1.68000000E+00	-6.25610295E-01	2.44325447E-01	-1.78801493E+00	-1.46359446E+00	1.43285827E+01	9.64487902E+00
1.74000000E+00	-5.84762304E-01	2.34165336E-01	-1.78105718E+00	-1.41208137E+00	1.49095736E+01	9.72108456E+00
1.80000000E+00	-5.44029908E-01	2.24007708E-01	-1.77445228E+00	-1.42376076E+00	1.54951009E+01	9.79672225E+00
1.86000000E+00	-5.04734670E-01	2.14415368E-01	-1.74741317E+00	-5.41855117E-01	1.60848011E+01	9.85103504E+00
1.92000000E+00	-4.65605844E-01	2.05197278E-01	-1.72494070E+00	-2.18168065E-01	1.66765088E+01	9.86922260E+00
1.98000000E+00	-4.26643431E-01	1.95816569E-01	-1.70702490E+00	-2.96593904E-01	1.72689677E+01	9.88009488E+00
2.04000000E+00	-3.87847431E-01	1.86218905E-01	-1.69365577E+00	-6.21026930E-01	1.78623690E+01	9.90309548E+00
2.10000000E+00	-3.49217843E-01	1.76645160E-01	-1.68482333E+00	-1.03536144E+00	1.84577895E+01	9.94830166E+00
2.16000000E+00	-3.10754668E-01	1.67444088E-01	-1.68051761E+00	-1.38349173E+00	1.90566298E+01	1.00164243E+01
2.22000000E+00	-2.72457906E-01	1.58885001E-01	-1.68072860E+00	-1.50931209E+00	1.96600519E+01	1.00988081E+01
2.28000000E+00	-2.34327556E-01	1.50970437E-01	-1.68544633E+00	-1.25671683E+00	2.02684178E+01	1.01774311E+01
2.34000000E+00	-1.96363619E-01	1.43248836E-01	-1.69466082E+00	-4.69600242E-01	2.08807269E+01	1.02249054E+01
2.40000000E+00	-1.58566095E-01	1.34627211E-01	-1.70836207E+00	1.00814338E+00	2.14940546E+01	1.02044764E+01
2.76000000E+00	5.99218746E-02	8.09215021E-02	-1.52094534E+00	1.45897492E+00	2.51023167E+01	9.81721642E+00
3.12000000E+00	2.57566797E-01	3.47062674E-02	-1.35722249E+00	1.91052866E+00	2.85449947E+01	9.28452184E+00
3.48000000E+00	4.34368671E-01	-5.08097061E-03	-1.20969003E+00	2.36029555E+00	3.17697396E+01	8.60658429E+00
3.84000000E+00	5.90327498E-01	-3.94254972E-02	-1.07084447E+00	2.80576654E+00	3.47244340E+01	7.78449865E+00
4.20000000E+00	7.25443277E-01	-6.91270146E-02	-9.33182301E-01	3.24443257E+00	3.73575170E+01	6.82026310E+00

4.56000000E+00	8.39716009E-01	-9.46912511E-02	-7.89200032E-01	3.67378460E+00	3.96183100E+01	5.71677903E+00
4.92000000E+00	9.33145693E-01	-1.16221569E-01	-6.31394164E-01	4.09131356E+00	4.14573411E+01	4.47785112E+00
5.28000000E+00	1.00573233E+00	-1.33310576E-01	-4.52261201E-01	4.49451040E+00	4.28266709E+01	3.10818731E+00
5.64000000E+00	1.05747592E+00	-1.44931731E-01	-2.44297645E-01	4.88086607E+00	4.36802173E+01	1.61339878E+00
6.00000000E+00	1.08837646E+00	-1.49330953E-01	5.24913446E-13	5.24787151E+00	4.39740811E+01	-4.86829096E-12
6.36000000E+00	1.05747592E+00	-1.44931731E-01	2.44297645E-01	4.88086607E+00	4.36802173E+01	-1.61339878E+00
6.72000000E+00	1.00573233E+00	-1.33310576E-01	4.52261201E-01	4.49451040E+00	4.28266709E+01	-3.10818731E+00
7.08000000E+00	9.33145693E-01	-1.16221569E-01	6.31394164E-01	4.09131356E+00	4.14573411E+01	-4.47785112E+00
7.44000000E+00	8.39716009E-01	-9.46912511E-02	7.89200032E-01	3.67378460E+00	3.96183100E+01	-5.71677903E+00
7.80000000E+00	7.25443277E-01	-6.91270146E-02	9.33182301E-01	3.24443257E+00	3.73575170E+01	-6.82026310E+00
8.16000000E+00	5.90327498E-01	-3.94254972E-02	1.07084447E+00	2.80576654E+00	3.47244340E+01	-7.78449865E+00
8.52000000E+00	4.34368671E-01	-5.08097061E-03	1.20969003E+00	2.36029555E+00	3.17697396E+01	-8.60658429E+00
8.88000000E+00	2.57566797E-01	3.47062674E-02	1.35722249E+00	1.91052866E+00	2.85449947E+01	-9.28452184E+00
9.24000000E+00	5.99218746E-02	8.09215021E-02	1.52094534E+00	1.45897492E+00	2.51023167E+01	-9.81721642E+00
9.60000000E+00	-1.58566095E-01	1.34627211E-01	1.70836207E+00	1.00814338E+00	2.14940546E+01	-1.02044764E+01
9.66000000E+00	-1.96363619E-01	1.43248836E-01	1.69466082E+00	-4.69600242E-01	2.08807269E+01	-1.02249054E+01
9.72000000E+00	-2.34327556E-01	1.50970437E-01	1.68544633E+00	-1.25671683E+00	2.02684178E+01	-1.01774311E+01
9.78000000E+00	-2.72457906E-01	1.58885001E-01	1.68072860E+00	-1.50931209E+00	1.96600519E+01	-1.00988081E+01
9.84000000E+00	-3.10754668E-01	1.67444088E-01	1.68051761E+00	-1.38349173E+00	1.90566298E+01	-1.00164243E+01
9.90000000E+00	-3.49217843E-01	1.76645160E-01	1.68482333E+00	-1.03536144E+00	1.84577895E+01	-9.94830166E+00
9.96000000E+00	-3.87847431E-01	1.86218905E-01	1.69365577E+00	-6.21026930E-01	1.78623690E+01	-9.90309548E+00
1.00200000E+01	-4.26643431E-01	1.95816569E-01	1.70702490E+00	-2.96593904E-01	1.72689677E+01	-9.88009488E+00
1.00800000E+01	-4.65605844E-01	2.05197278E-01	1.72494070E+00	-2.18168065E-01	1.66765088E+01	-9.86922260E+00
1.01400000E+01	-5.04734670E-01	2.14415368E-01	1.74741317E+00	-5.41855117E-01	1.60848011E+01	-9.85103504E+00
1.02000000E+01	-5.44029908E-01	2.24007708E-01	1.77445228E+00	-1.42376076E+00	1.54951009E+01	-9.79672225E+00
1.02600000E+01	-5.84762304E-01	2.34165336E-01	1.78105718F+00	-1.41208137E+00	1.49095736E+01	-9.72108456E+00
1.03200000E+01	-6.25610295E-01	2.44325447E-01	1.78801493E+00	-1.46359446E+00	1.43285827E+01	-9.64487902E+00
1.03800000E+01	-6.66573881E-01	2.54422762E-01	1.79533246E+00	-1.56409497E+00	1.37522673E+01	-9.56674023E+00
1.04400000E+01	-7.07653062E-01	2.64450787E-01	1.80301671E+00	-1.69937786F+00	1.31809433E+01	-9.47815511E+00
1.05000000E+01	-7.48847838E-01	2.74444767E-01	1.81107460E+00	-1.85523809E+00	1.26150514E+01	-9.38346285E+00
1.05600000E+01	-7.90158209E-01	2.84446640E-01	1.81951309E+00	-2.01747062E+00	1.20551067E+01	-9.27985498E+00
1.06200000E+01	-8.31584174E-01	2.94577990E-01	1.82833909E+00	-2.17187039E+00	1.15016468E+01	-9.16737530E+00
1.06800000E+01	-8.73125735E-01	3.04843003E-01	1.83755956E+00	-2.30423237E+00	1.09551817E+01	-9.04691994E+00
1.07400000E+01	-9.14782891E-01	3.15291417E-01	1.84718141E+00	-2.40035150E+00	1.04161416E+01	-8.92023730E+00
1.08000000E+01	-9.56555642E-01	3.25911483E-01	1.85721160E+00	-2.44602275E+00	9.88482632E+00	-8.78992812E+00
1.08300000E+01	-9.78038648E-01	3.31239351E-01	1.86014617E+00	-2.57229386E+00	9.62211954E+00	-8.72326339E+00
1.08600000E+01	-9.99481264E-01	3.36545787E-01	1.86306701E+00	-2.66966367E+00	9.36146152E+00	-8.65348834E+00
1.08900000E+01	-1.02088349E+00	3.41840525E-01	1.86597294E+00	-2.74817192E+00	9.10293408E+00	-8.58131942E+00
1.09200000E+01	-1.04224532E+00	3.47127641E-01	1.86886272E+00	-2.81785837E+00	8.84660205E+00	-8.50717187E+00
1.09500000E+01	-1.06356677E+00	3.52408563E-01	1.87173515E+00	-2.88876276E+00	8.59252231E+00	-8.43115977E+00
1.09800000E+01	-1.08484782E+00	3.57685085E-01	1.87458901E+00	-2.97092484E+00	8.34075288E+00	-8.35309597E+00
1.10100000E+01	-1.10608848E+00	3.62962380E-01	1.87742310E+00	-3.07438435E+00	8.09136186E+00	-8.27249214E+00
1.10400000E+01	-1.12728875E+00	3.68252008E-01	1.88023621E+00	-3.20918104E+00	7.84443654E+00	-8.18855877E+00
1.10700000E+01	-1.14844863E+00	3.73574932E-01	1.88302711E+00	-3.38535465E+00	7.60009243E+00	-8.10020514E+00
1.11000000E+01	-1.16956812E+00	3.78964525E-01	1.88579461E+00	-3.61294494E+00	7.35848225E+00	-8.00603936E+00
1.11300000E+01	-1.19137631E+00	3.84461443E-01	1.88870420E+00	-3.70409137E+00	7.11977339E+00	-7.90747030E+00
1.11600000E+01	-1.21321171E+00	3.90085436E-01	1.89146721E+00	-3.91527016E+00	6.88407816E+00	-7.80453031E+00
1.11900000E+01	-1.23507434E+00	3.95874788E-01	1.89408443E+00	-4.20522971E+00	6.65157552E+00	-7.69423720E+00
1.12200000E+01	-1.25696419E+00	4.01891418E-01	1.89655670E+00	-4.53271845E+00	6.42251532E+00	-7.57484631E+00
1.12500000E+01	-1.27888127E+00	4.08208505E-01	1.89888482E+00	-4.85648480E+00	6.19718120E+00	-7.44585056E+00
1.12800000E+01	-1.30082557E+00	4.14898110E-01	1.90106962E+00	-5.13527716E+00	5.97585344E+00	-7.30798037E+00
1.13100000E+01	-1.32279709E+00	4.22018801E-01	1.90311190E+00	-5.32784397E+00	5.75877185E+00	-7.16320376E+00
1.13400000E+01	-1.34479584E+00	4.29603280E-01	1.90501250E+00	-5.39293364E+00	5.54609864E+00	-7.01472625E+00
1.13700000E+01	-1.36682182E+00	4.37646006E-01	1.90677222E+00	-5.28929459E+00	5.33788127E+00	-6.86699093E+00
1.14000000E+01	-1.38887501E+00	4.46090817E-01	1.90839188E+00	-4.97567523E+00	5.13401537E+00	-6.72567844E+00
1.14300000E+01	-1.41284599E+00	4.54880808E-01	1.91278613E+00	-4.66322746E+00	4.93427705E+00	-6.59183331E+00
1.14600000E+01	-1.43626031E+00	4.63906726E-01	1.91680619E+00	-3.63969757E+00	4.73830056E+00	-6.47844591E+00
1.14900000E+01	-1.45911795E+00	4.72829528E-01	1.92043537E+00	-1.92764564E+00	4.54515556E+00	-6.40651028E+00
1.15200000E+01	-1.48141892E+00	4.81103614E-01	1.92365696E+00	4.50368277E-01	4.35329203E+00	-6.39634370E+00
1.15500000E+01	-1.50316322E+00	4.87983594E-01	1.92645426E+00	3.47178412E+00	4.16056061E+00	-6.46758663E+00
1.15800000E+01	-1.52435085E+00	4.92531059E-01	1.92881058E+00	7.11404182E+00	3.96423288E+00	-6.63920271E+00
1.16100000E+01	-1.54498181E+00	4.93621346E-01	1.93070921E+00	1.13545813E+01	3.76102163E+00	-6.92947880E+00
1.16400000E+01	-1.56505610E+00	4.89950309E-01	1.93213345E+00	1.61708426E+01	3.54710122E+00	-7.35602496E+00
1.16700000E+01	-1.58457372E+00	4.80041084E-01	1.93306661E+00	2.15402655E+01	3.31812787E+00	-7.93577444E+00
1.17000000E+01	-1.60353467E+00	4.62250859E-01	1.93349198E+00	2.74402901E+01	3.06925993E+00	-8.68498368E+00
1.17300000E+01	-1.60872778E+00	4.34972390E-01	1.93365558F+00	3.02855885E+01	2.79571518E+00	-9.56605262E+00
1.17600000E+01	-1.61335255E+00	3.97107017E-01	1.92855350E+00	3.23060919E+01	2.49446798E+00	-1.05276899E+01
1.17900000E+01	-1.61740896E+00	3.47943971E-01	1.91816867E+00	3.11910149E+01	2.16381906E+00	-1.15104898E+01
1.18200000E+01	-1.62089701E+00	2.87713154E-01	1.90248405E+00	2.46295726E+01	1.80489115E+00	-1.23857232E+01
1.18500000E+01	-1.62381672E+00	2.18278382E-01	1.88148259E+00	1.03109796E+01	1.42370875E+00	-1.29553374E+01
1.18800000E+01	-1.62616807E+00	1.43830611E-01	1.85514723E+00	-1.40755492E+01	1.03327776E+00	-1.29519560E+01
1.19100000E+01	-1.62795108E+00	7.15811829E-02	1.82346092E+00	-5.08407990E+01	6.55665236E-01	-1.20388792E+01
1.19400000E+01	-1.62916573E+00	1.24550519E-02	1.78640662E+00	-1.02295555E+02	3.24079085E-01	-9.81008367E+00
1.19700000E+01	-1.62981202E+00	-1.82159741E-02	1.74396727E+00	-1.70750602E+02	8.49477659E-02	-5.79022234E+00
1.20000000E+01	-1.62988997E+00	-4.25210793E-13	1.69612582E+00	-2.58516726E+02	-1.35026249E-13	5.65375274E-01

TABLE VII.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 1 - Continued

(f) Extreme-fiber strains corresponding to the lowest frequency of cylinder

EXTREME FIBER STRAINS CORRESPONDING TO FREQUENCY 1

X	E1 POSITIVE	E1 NEGATIVE	E2 POSITIVE	E2 NEGATIVE	E12 POSITIVE	E12 NEGATIVE
0.	-2.92247360E+00	-3.37306343E-01	-4.30331496E-15	-4.26384025E-15	-1.69895270E+00	-1.69329895E+00
3.00000000E-02	-2.48356503E+00	-7.76059015E-01	-1.77616325E-02	-1.86718326E-02	-1.68321144E+00	-1.80482929E+00
6.00000000E-02	-2.14064350E+00	-1.11768795E+00	1.40520272E-02	1.08527443E-02	-1.68541501E+00	-1.88757166E+00
9.00000000E-02	-1.88215507E+00	-1.37374708E+00	7.47349508E-02	6.84168848E-02	-1.70013824E+00	-1.94699438E+00
1.20000000E-01	-1.69654582E+00	-1.55579033E+00	1.48749085E-01	1.38895715E-01	-1.72264865E+00	-1.98787197E+00
1.50000000E-01	-1.57226182E+00	-1.67537162E+00	2.25021889E-01	2.11512359E-01	-1.74890641E+00	-2.01428514E+00
1.80000000E-01	-1.49774915E+00	-1.74404488E+00	2.96243870E-01	2.79153955E-01	-1.77556433E+00	-2.02962077E+00
2.10000000E-01	-1.46145388E+00	-1.77336403E+00	3.58166122E-01	3.37687688E-01	-1.79996791E+00	-2.03657194E+00
2.40000000E-01	-1.45182209E+00	-1.77488301E+00	4.08897860E-01	3.85276805E-01	-1.82015528E+00	-2.03713790E+00
2.70000000E-01	-1.45729984E+00	-1.76015573E+00	4.48203959E-01	4.21696641E-01	-1.83485725E+00	-2.03262410E+00
3.00000000E-01	-1.46633322E+00	-1.74073612E+00	4.76802488E-01	4.47650643E-01	-1.84349727E+00	-2.02364217E+00
3.30000000E-01	-1.47687239E+00	-1.69227505E+00	4.95805381E-01	4.64224151E-01	-1.85055847E+00	-2.01571775E+00
3.60000000E-01	-1.48420189E+00	-1.64591031E+00	5.06841080E-01	4.73003141E-01	-1.85541953E+00	-2.00898070E+00
3.90000000E-01	-1.48820890E+00	-1.60175472E+00	5.11573831E-01	4.75608919E-01	-1.85825957E+00	-2.00328506E+00
4.20000000E-01	-1.48878064E+00	-1.55992106E+00	5.11499724E-01	4.73499060E-01	-1.85926445E+00	-1.99847807E+00
4.50000000E-01	-1.48580430E+00	-1.52052214E+00	5.07939831E-01	4.67960726E-01	-1.85862678E+00	-1.99440023E+00
4.80000000E-01	-1.47916708E+00	-1.48367076E+00	5.02033352E-01	4.60103994E-01	-1.85654597E+00	-1.99088523E+00
5.10000000E-01	-1.46875618E+00	-1.44947972E+00	4.94730755E-01	4.50855176E-01	-1.85322816E+00	-1.98776001E+00
5.40000000E-01	-1.45445879E+00	-1.41806182E+00	4.86786917E-01	4.40950140E-01	-1.84888627E+00	-1.98484474E+00
5.70000000E-01	-1.43616213E+00	-1.38952986E+00	4.78754269E-01	4.30927635E-01	-1.84373996E+00	-1.98195278E+00
6.00000000E-01	-1.41375339E+00	-1.36399664E+00	4.70975934E-01	4.21122612E-01	-1.83801569E+00	-1.97889077E+00
6.30000000E-01	-1.39326829E+00	-1.34037534E+00	4.63562808E-01	4.11642671E-01	-1.83498677E+00	-1.97868271E+00
6.60000000E-01	-1.37176051E+00	-1.31783117E+00	4.56572819E-01	4.02543693E-01	-1.83175386E+00	-1.97839864E+00
6.90000000E-01	-1.34943631E+00	-1.29615787E+00	4.50062556E-01	3.93881411E-01	-1.82837288E+00	-1.97798088E+00
7.20000000E-01	-1.32650196E+00	-1.27514918E+00	4.44037315E-01	3.85661612E-01	-1.82488743E+00	-1.97738416E+00
7.50000000E-01	-1.30316369E+00	-1.25459884E+00	4.38463638E-01	3.77852353E-01	-1.82132872E+00	-1.97657557E+00
7.80000000E-01	-1.27962778E+00	-1.23430060E+00	4.33281858E-01	3.70396169E-01	-1.81771558E+00	-1.97553459E+00
8.10000000E-01	-1.25610049E+00	-1.21404819E+00	4.28418634E-01	3.63222281E-01	-1.81405452E+00	-1.97425311E+00
8.40000000E-01	-1.23278806E+00	-1.19363536E+00	4.23799494E-01	3.56258810E-01	-1.81033963E+00	-1.97273536E+00
8.70000000E-01	-1.20989676E+00	-1.17285585E+00	4.19361374E-01	3.49444984E-01	-1.80655268E+00	-1.97099801E+00
9.00000000E-01	-1.18763285E+00	-1.15150340E+00	4.15065161E-01	3.42743353E-01	-1.80266306E+00	-1.96907007E+00
9.30000000E-01	-1.16537541E+00	-1.13152186E+00	4.10890576E-01	3.36134694E-01	-1.79895929E+00	-1.96724040E+00
9.60000000E-01	-1.14333466E+00	-1.11124285E+00	4.06796198E-01	3.29579124E-01	-1.79529023E+00	-1.96532911E+00
9.90000000E-01	-1.12146040E+00	-1.09071656E+00	4.02747943E-01	3.23043978E-01	-1.79164317E+00	-1.96335134E+00
1.02000000E+00	-1.09970244E+00	-1.06999320E+00	3.98724309E-01	3.16508836E-01	-1.78800843E+00	-1.96131923E+00
1.05000000E+00	-1.07801058E+00	-1.04912295E+00	3.94713319E-01	3.09962555E-01	-1.78437932E+00	-1.95924189E+00
1.08000000E+00	-1.05633461E+00	-1.02815603E+00	3.90709468E-01	3.03400298E-01	-1.78075218E+00	-1.95712542E+00
1.11000000E+00	-1.03462435E+00	-1.00714263E+00	3.86710678E-01	2.96820556E-01	-1.77712635E+00	-1.95497291E+00
1.14000000E+00	-1.01282958E+00	-9.86132945E-01	3.82715236E-01	2.90222183E-01	-1.77350418E+00	-1.95278443E+00
1.17000000E+00	-9.90900117E-01	-9.65177179E-01	3.78718750E-01	2.83601422E-01	-1.76989102E+00	-1.95055703E+00
1.20000000E+00	-9.68785755E-01	-9.44325528E-01	3.74711096E-01	2.76948932E-01	-1.76629525E+00	-1.94828477E+00
1.26000000E+00	-9.26786648E-01	-9.02781133E-01	3.66760857E-01	2.63650126E-01	-1.75497974E+00	-1.93954202E+00
1.32000000E+00	-8.84646897E-01	-8.61604573E-01	3.59020544E-01	2.50484568E-01	-1.74410812E+00	-1.93117198E+00
1.38000000E+00	-8.42443526E-01	-8.20724822E-01	3.51500390E-01	2.37465532E-01	-1.73369945E+00	-1.92314169E+00
1.44000000E+00	-8.00245562E-01	-7.80070855E-01	3.44166562E-01	2.24563779E-01	-1.72376426E+00	-1.91542668E+00
1.50000000E+00	-7.58124028E-01	-7.39571647E-01	3.36958427E-01	2.11722381E-01	-1.71430461E+00	-1.90801105E+00
1.56000000E+00	-7.16149951E-01	-6.99156173E-01	3.29805827E-01	1.98877533E-01	-1.70531398E+00	-1.90088742F+00
1.62000000E+00	-6.74394356E-01	-6.58753406E-01	3.22646355E-01	1.85971378E-01	-1.69677739E+00	-1.89405692E+00
1.68000000E+00	-6.32928268E-01	-6.18292323E-01	3.15442623E-01	1.72970818E-01	-1.68867132E+00	-1.88752923E+00
1.74000000E+00	-5.91822711E-01	-5.77701898E-01	3.08199538E-01	1.59883941E-01	-1.68096372E+00	-1.88132256E+00
1.80000000E+00	-5.51148712E-01	-5.36911105E-01	3.00981576E-01	1.46776832E-01	-1.67361406E+00	-1.87546363E+00
1.86000000E+00	-5.07443945E-01	-5.02025394E-01	2.94348792E-01	1.34215054E-01	-1.64607726E+00	-1.84892296E+00
1.92000000E+00	-4.66696684E-01	-4.64515004E-01	2.88099656E-01	1.22018098E-01	-1.62346046E+00	-1.82659501E+00
1.98000000E+00	-4.28126400E-01	-4.25160461E-01	2.81691921E-01	1.09654488E-01	-1.60546584E+00	-1.80875811E+00
2.04000000E+00	-3.90952565E-01	-3.84742296E-01	2.75072296E-01	9.70688413E-02	-1.59188914E+00	-1.79559686E+00
2.10000000E+00	-3.54396650E-01	-3.44041036E-01	2.68486630E-01	8.44970403E-02	-1.58261971E+00	-1.78720212E+00
2.16000000E+00	-3.17672127E-01	-3.03837209E-01	2.62290087E-01	7.22814084E-02	-1.57764049E+00	-1.78357100E+00
2.22000000E+00	-2.80004466E-01	-2.64911345E-01	2.56757332E-01	6.06858850E-02	-1.57702798E+00	-1.78460687E+00
2.28000000E+00	-2.40611140E-01	-2.28043972E-01	2.51892705E-01	4.97112004E-02	-1.58095229E+00	-1.79011937E+00
2.34000000E+00	-1.98711620E-01	-1.94015618E-01	2.47240403E-01	3.89100512E-02	-1.58967710E+00	-1.79982437E+00
2.40000000E+00	-1.53525378E-01	-1.63606812E-01	2.41694659E-01	2.72022746E-02	-1.60355967E+00	-1.81334404E+00
2.76000000E+00	6.72167491E-02	5.26270000E-02	2.06089603E-01	-4.46645220E-02	-1.42032416E+00	-1.62173859E+00
3.12000000E+00	2.67119440E-01	2.48014153E-01	1.77136014E-01	-1.08199038E-01	-1.26219624E+00	-1.45241102E+00
3.48000000E+00	4.46170149E-01	4.22567193E-01	1.53511874E-01	-1.64203341E-01	-1.12168300E+00	-1.29784723E+00
3.84000000E+00	6.04356331E-01	5.76298665E-01	1.33973384E-01	-2.13403339E-01	-9.91282475E-01	-1.15054216E+00
4.20000000E+00	7.41665440E-01	7.09221114E-01	1.17464796E-01	-2.56341836E-01	-8.63483695E-01	-1.00299976E+00

4.56000000E+00	8.58084932E-01	8.21347086E-01	1.03228252E-01	-2.93271587E-01	-7.30766657E-01	-8.47733071E-01
4.92000000E+00	9.53602261E-01	9.12689125E-01	9.09136132E-02	-3.24048355E-01	-5.85602334E-01	-6.77264134E-01
5.28000000E+00	1.02820488E+00	9.83259777E-01	8.06882975E-02	-3.48023970E-01	-4.20452672E-01	-4.84124046E-01
5.64000000E+00	1.08188025E+00	1.03307159E+00	7.33471109E-02	-3.63939383E-01	-2.27770595E-01	-2.60852943E-01
6.00000000E+00	1.11461582E+00	1.06213710E+00	7.04220828E-02	-3.69817721E-01	4.75397638E-13	5.74513309E-13
6.36000000E+00	1.08188025E+00	1.03307159E+00	7.33471109E-02	-3.63939383E-01	2.27770595E-01	2.60852943E-01
6.72000000E+00	1.02820488E+00	9.83259777E-01	8.06882975E-02	-3.48023970E-01	4.20452672E-01	4.84124046E-01
7.08000000E+00	9.53602261E-01	9.12689125E-01	9.09136132E-02	-3.24048355E-01	5.85602334E-01	6.77264134E-01
7.44000000E+00	8.58084932E-01	8.21347086E-01	1.03228252E-01	-2.93271587E-01	7.30766657E-01	8.47733071E-01
7.80000000E+00	7.41665440E-01	7.09221114E-01	1.17464796E-01	-2.56341836E-01	8.63483695E-01	1.00299976E+00
8.16000000E+00	6.04356331E-01	5.76298665E-01	1.33973384E-01	-2.13403339E-01	9.91282475E-01	1.15054216E+00
8.52000000E+00	4.46170149E-01	4.22567193E-01	1.53511874E-01	-1.64203341E-01	1.12168300E+00	1.29784723E+00
8.88000000E+00	2.67119440E-01	2.48014153E-01	1.77136014E-01	-1.08199038E-01	1.26219624E+00	1.45241102E+00
9.24000000E+00	6.72167491E-02	5.26270000E-02	2.06089603E-01	-4.46645220E-02	1.42032416E+00	1.62173859E+00
9.60000000E+00	-1.53525378E-01	-1.63606812E-01	2.41694659E-01	2.72022746E-02	1.60355967E+00	1.81334404E+00
9.66000000E+00	-1.98711620E-01	-1.94015618E-01	2.47240403E-01	3.89100512E-02	1.58967710E+00	1.79982437E+00
9.72000000E+00	-2.40611140E-01	-2.28043972E-01	2.51892705E-01	4.97112004E-02	1.58095229E+00	1.79011937E+00
9.78000000E+00	-2.80004466E-01	-2.64911345E-01	2.56757332E-01	6.06858850E-02	1.57702798E+00	1.78460687E+00
9.84000000E+00	-3.17672127E-01	-3.03837209E-01	2.62290087E-01	7.22814084E-02	1.57764049E+00	1.78357100E+00
9.90000000E+00	-3.54394650E-01	-3.44041036E-01	2.68486630E-01	8.44970403E-02	1.58261971E+00	1.78720212E+00
9.96000000E+00	-3.90952565E-01	-3.84742296E-01	2.75072296E-01	9.70688413E-02	1.59188914E+00	1.79559686E+00
1.00200000E+01	-4.28126400E-01	-4.25160461E-01	2.81691921E-01	1.09654488E-01	1.60546584E+00	1.80875811E+00
1.00800000E+01	-4.66696684E-01	-4.64515004E-01	2.88099656E-01	1.22018098E-01	1.62346046E+00	1.82659501E+00
1.01400000E+01	-5.07443945E-01	-5.02025394E-01	2.94348792E-01	1.34215054E-01	1.64607726E+00	1.84892296E+00
1.02000000E+01	-5.51148712E-01	-5.36911105E-01	3.00981576E-01	1.46776832E-01	1.67361406E+00	1.87546363E+00
1.02600000E+01	-5.91822711E-01	-5.77701898E-01	3.08199538E-01	1.59883941E-01	1.68096372E+00	1.88132256E+00
1.03200000E+01	-6.32928268E-01	-6.18292323E-01	3.15442623E-01	1.72970818E-01	1.68867132E+00	1.88752923E+00
1.03800000E+01	-6.74394356E-01	-6.58753406E-01	3.22646355E-01	1.85971378E-01	1.69677739E+00	1.89405692E+00
1.04400000E+01	-7.16149951E-01	-6.99156173E-01	3.29805827E-01	1.98877533E-01	1.70531398E+00	1.90088742E+00
1.05000000E+01	-7.58124028E-01	-7.39571647E-01	3.36958427E-01	2.11722381E-01	1.71430461E+00	1.90801105E+00
1.05600000E+01	-8.00245562E-01	-7.80070855E-01	3.44166562E-01	2.24563379E-01	1.72376426E+00	1.91542668E+00
1.06200000E+01	-8.42443526E-01	-8.20724822E-01	3.51500390E-01	2.37465532E-01	1.73369945E+00	1.92314169E+00
1.06800000E+01	-8.84646897E-01	-8.61604573E-01	3.59020544E-01	2.50484568E-01	1.74410812E+00	1.93117198E+00
1.07400000E+01	-9.26784648E-01	-9.02781133E-01	3.66760857E-01	2.63650126E-01	1.75497974E+00	1.93954202E+00
1.08000000E+01	-9.68785755E-01	-9.44325528E-01	3.74711096E-01	2.76948932E-01	1.76629525E+00	1.94828477E+00
1.08300000E+01	-9.90900117E-01	-9.65177179E-01	3.78718750E-01	2.83601422E-01	1.76989102E+00	1.95055703E+00
1.08600000E+01	-1.01282958E+00	-9.86132945E-01	3.82715236E-01	2.90222183E-01	1.77350418E+00	1.95278443E+00
1.08900000E+01	-1.03462435E+00	-1.00714263E+00	3.86710678E-01	2.96820556E-01	1.77712635E+00	1.95497291E+00
1.09200000E+01	-1.05633461E+00	-1.02815603E+00	3.90709468E-01	3.03400298E-01	1.78075218E+00	1.95712542E+00
1.09500000E+01	-1.07801058E+00	-1.04912295E+00	3.94713319E-01	3.09962555E-01	1.78437932E+00	1.95924189E+00
1.09800000E+01	-1.09970244E+00	-1.06999320E+00	3.98724309E-01	3.16508836E-01	1.78800843E+00	1.96131923E+00
1.10100000E+01	-1.12146040E+00	-1.09071656E+00	4.02747943E-01	3.23043978E-01	1.79164317E+00	1.96335134E+00
1.10400000E+01	-1.14333466E+00	-1.11124285E+00	4.06796198E-01	3.29579124E-01	1.79529023E+00	1.96532911E+00
1.10700000E+01	-1.16537541E+00	-1.13152186E+00	4.10890576E-01	3.36134694E-01	1.79895929E+00	1.96724040E+00
1.11000000E+01	-1.18763285E+00	-1.15150340E+00	4.15065161E-01	3.42743353E-01	1.80266306E+00	1.96907007E+00
1.11300000E+01	-1.20989676E+00	-1.17285585E+00	4.19361374E-01	3.49444984E-01	1.80655268E+00	1.97099801E+00
1.11600000E+01	-1.23278806E+00	-1.19363536E+00	4.23799494E-01	3.56258810E-01	1.81033963E+00	1.97273536E+00
1.11900000E+01	-1.25610049E+00	-1.21404819E+00	4.28418634E-01	3.63222281E-01	1.81405452E+00	1.97425311E+00
1.12200000E+01	-1.27962778E+00	-1.23430060E+00	4.33281858E-01	3.70396169E-01	1.81771558E+00	1.97553459E+00
1.12500000E+01	-1.30316369E+00	-1.25459884E+00	4.38463638E-01	3.77852353E-01	1.82132872E+00	1.97657557E+00
1.12800000E+01	-1.32650196E+00	-1.27514918E+00	4.44037315E-01	3.85661612E-01	1.82488743E+00	1.97738416E+00
1.13100000E+01	-1.34943631E+00	-1.29615787E+00	4.50062556E-01	3.93881411E-01	1.82837288E+00	1.97798088E+00
1.13400000E+01	-1.37176051E+00	-1.31783117E+00	4.56572819E-01	4.02543693E-01	1.83175386E+00	1.97839864E+00
1.13700000E+01	-1.39326829E+00	-1.34037534E+00	4.63562808E-01	4.11642671E-01	1.83498677E+00	1.97868271E+00
1.14000000E+01	-1.41375339E+00	-1.36399664E+00	4.70975934E-01	4.21122612E-01	1.83801569E+00	1.97889077E+00
1.14300000E+01	-1.43616213E+00	-1.38952986E+00	4.78754269E-01	4.30927635E-01	1.84373996E+00	1.98195278E+00
1.14600000E+01	-1.45445879E+00	-1.41806182E+00	4.86786917E-01	4.40950140E-01	1.84888627E+00	1.98484474E+00
1.14900000E+01	-1.46875618E+00	-1.44947972E+00	4.94730755E-01	4.50855176E-01	1.85322816E+00	1.98776001E+00
1.15200000E+01	-1.47916708E+00	-1.48367076E+00	5.02033352E-01	4.60103994E-01	1.85654597E+00	1.99088523E+00
1.15500000E+01	-1.48580430E+00	-1.52052214E+00	5.07939831E-01	4.67960726E-01	1.85862678E+00	1.99440023E+00
1.15800000E+01	-1.48878064E+00	-1.55992106E+00	5.11499724E-01	4.73499060E-01	1.85926445E+00	1.99847807E+00
1.16100000E+01	-1.48820890E+00	-1.60175472E+00	5.11573831E-01	4.75608919E-01	1.85825957E+00	2.00328506E+00
1.16400000E+01	-1.48420189E+00	-1.64591031E+00	5.06841080E-01	4.73003141E-01	1.85541953E+00	2.00898070E+00
1.16700000E+01	-1.47687239E+00	-1.69227505E+00	4.95805381E-01	4.64224151E-01	1.85055847E+00	2.01571775E+00
1.17000000E+01	-1.46633322E+00	-1.74073612E+00	4.76802488E-01	4.47650643E-01	1.84349727E+00	2.02364217E+00
1.17300000E+01	-1.45729984E+00	-1.76015573E+00	4.48203959E-01	4.21696641E-01	1.83485725E+00	2.03262410E+00
1.17600000E+01	-1.45182209E+00	-1.77488301E+00	4.08897860E-01	3.85276805E-01	1.82015528E+00	2.03713790E+00
1.17900000E+01	-1.46145388E+00	-1.77336403E+00	3.58166122E-01	3.37687688E-01	1.79996791E+00	2.03657194E+00
1.18200000E+01	-1.49774915E+00	-1.74404488E+00	2.96243870E-01	2.79153955E-01	1.77556433E+00	2.02962077E+00
1.18500000E+01	-1.57226182E+00	-1.67537162E+00	2.25021889E-01	2.11512359E-01	1.74890641E+00	2.01428514E+00
1.18800000E+01	-1.69654582E+00	-1.55579033E+00	1.48749085E-01	1.38895715E-01	1.72264865E+00	1.98787197E+00
1.19100000E+01	-1.88215507E+00	-1.3737470BE+00	7.47349508E-02	6.84168848E-02	1.70013824E+00	1.94699438E+00
1.19400000E+01	-2.14064350E+00	-1.11768795E+00	1.40520272E-02	1.08527443E-02	1.68541501E+00	1.88757166E+00
1.19700000E+01	-2.48356503E+00	-7.76059015E-01	-1.77616325E-02	-1.86718326E-02	1.68321144E+00	1.80482929E+00
1.20000000E+01	-2.92247360E+00	-3.37306343E-01	-4.25177295E-13	-4.25244402E-13	1.69895270E+00	1.69329895E+00

TABLE VII.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 1 - Continued

(g) Extreme-fiber stresses corresponding to the lowest frequency of cylinder

EXTREME FIBER STRESSES CORRESPONDING TO FREQUENCY 1

X	SIGMA SUB 1 (POSITIVE)	SIGMA SUB 1 (NEGATIVE)	SIGMA SUB 2 (POSITIVE)	SIGMA SUB 2 (NEGATIVE)	SIGMA SUB 12 (POSITIVE)	SIGMA SUB 12 (NEGATIVE)
0.	-9.63452835E+07	-1.11998893E+07	-2.89035851E+07	-3.33599630E+06	-1.96033012E+07	-1.95360656E+07
3.00000000E-02	-8.20514349E+07	-2.57650296E+07	-2.51482794E+07	-8.29086336E+06	-1.94216713E+07	-2.08249542E+07
6.00000000E-02	-7.04316888E+07	-3.67395207E+07	-2.07079458E+07	-1.06962739E+07	-1.94470970E+07	-2.17796738E+07
9.00000000E-02	-6.13099314E+07	-4.46117149E+07	-1.61509309E+07	-1.13310079E+07	-1.96169805E+07	-2.24653207E+07
1.20000000E-01	-5.44589372E+07	-4.99160971E+07	-1.18752086E+07	-1.08079577E+07	-1.98767160E+07	-2.29369852E+07
1.50000000E-01	-4.96073161E+07	-5.31401509E+07	-8.13153817E+06	-9.59667451E+06	-2.01796901E+07	-2.32417526E+07
1.80000000E-01	-4.64464612E+07	-5.47351217E+07	-5.04562225E+06	-8.04591734E+06	-2.04872916E+07	-2.34187021E+07
2.10000000E-01	-4.46374960E+07	-5.51227821E+07	-2.64626512E+06	-6.40620339E+06	-2.07688613E+07	-2.34989079E+07
2.40000000E-01	-4.38182218E+07	-5.47021966E+07	-8.78530735E+05	-4.85235483E+06	-2.10017925E+07	-2.35054382E+07
2.70000000E-01	-4.36100655E+07	-5.38564858E+07	3.63099109E+05	-3.50604649E+06	-2.11714306E+07	-2.34533559E+07
3.00000000E-01	-4.36250266E+07	-5.29595910E+07	1.21656664E+06	-2.45835801E+06	-2.12711232E+07	-2.33497183E+07
3.30000000E-01	-4.37845312E+07	-5.11980595E+07	1.73880206E+06	-1.43269331E+06	-2.13525985E+07	-2.32582826E+07
3.60000000E-01	-4.39170186E+07	-4.95627266E+07	2.03012680E+06	-6.84723732E+05	-2.14086878E+07	-2.31805475E+07
3.90000000E-01	-4.40023106E+07	-4.81012761E+07	2.14652175E+06	-1.52115251E+05	-2.14414575E+07	-2.31148285E+07
4.20000000E-01	-4.40218920E+07	-4.67430113E+07	2.13842411E+06	1.82068407E+05	-2.14530522E+07	-2.30593633E+07
4.50000000E-01	-4.39589786E+07	-4.54589205E+07	2.05050135E+06	3.89145609E+05	-2.14456945E+07	-2.30123113E+07
4.80000000E-01	-4.37985848E+07	-4.43617438E+07	1.92142512E+06	4.94596675E+05	-2.14216851E+07	-2.29717536E+07
5.10000000E-01	-4.35275917E+07	-4.33260385E+07	1.78364512E+06	5.27843736E+05	-2.13834027E+07	-2.29356634E+07
5.40000000E-01	-4.31348149E+07	-4.23882454E+07	1.66316305E+06	5.12030593E+05	-2.13333039E+07	-2.29020556E+07
5.70000000E-01	-4.26110720E+07	-4.15467549E+07	1.57930648E+06	4.63802573E+05	-2.12730235E+07	-2.28686869E+07
6.00000000E-01	-4.19492508E+07	-4.08019731E+07	1.54450279E+06	3.93086406E+05	-2.12078741E+07	-2.28333559E+07
6.30000000E-01	-4.13472345E+07	-4.01170068E+07	1.50271389E+06	3.14178072E+05	-2.11729251E+07	-2.28309552E+07
6.60000000E-01	-4.07073186E+07	-3.94637824E+07	1.48498898E+06	2.37176032E+05	-2.11356223E+07	-2.28276775E+07
6.90000000E-01	-4.00357433E+07	-3.88349489E+07	1.49115369E+06	1.65957650E+05	-2.10966111E+07	-2.28228573E+07
7.20000000E-01	-3.93392558E+07	-3.82236494E+07	1.51934269E+06	1.02753527E+05	-2.10563943E+07	-2.28159720E+07
7.50000000E-01	-3.86249868E+07	-3.76234002E+07	1.56641310E+06	4.85505437E+04	-2.10153322E+07	-2.28066421E+07
7.80000000E-01	-3.79003261E+07	-3.70279697E+07	1.62835791E+06	3.49413654E+03	-2.09736422E+07	-2.27946308E+07
8.10000000E-01	-3.71727988E+07	-3.64312584E+07	1.70071939E+06	-3.27091133E+04	-2.09313991E+07	-2.27798444E+07
8.40000000E-01	-3.64499411E+07	-3.58271775E+07	1.77900250E+06	-5.03895484E+04	-2.08885350E+07	-2.27623320E+07
8.70000000E-01	-3.57391764E+07	-3.52095281E+07	1.85908833E+06	-7.95089005E+04	-2.08448395E+07	-2.27422856E+07
9.00000000E-01	-3.50476912E+07	-3.45718811E+07	1.93764746E+06	-8.92637571E+04	-2.07999592E+07	-2.27200402E+07
9.30000000E-01	-3.43552165E+07	-3.39795054E+07	2.02015233E+06	-1.09512009E+05	-2.07572235E+07	-2.26989286E+07
9.60000000E-01	-3.36690923E+07	-3.33748058E+07	2.10315824E+06	-1.25068025E+05	-2.07148681E+07	-2.26768752E+07
9.90000000E-01	-3.29880007E+07	-3.27627483E+07	2.18603809E+06	-1.37505172E+05	-2.06728067E+07	-2.26540548E+07
1.02000000E+00	-3.23104995E+07	-3.21441938E+07	2.26857944E+06	-1.47993059E+05	-2.06308673E+07	-2.26306074E+07
1.05000000E+00	-3.16350522E+07	-3.15209072E+07	2.35088389E+06	-1.57365507E+05	-2.05888930E+07	-2.26066381E+07
1.08000000E+00	-3.09600585E+07	-3.08945915E+07	2.43326651E+06	-1.66368517E+05	-2.05471414E+07	-2.25822173E+07
1.11000000E+00	-3.02838839E+07	-3.02669163E+07	2.51615516E+06	-1.75458236E+05	-2.05053049E+07	-2.25573806E+07
1.14000000E+00	-2.96048905E+07	-2.96395480E+07	2.59999993E+06	-1.85168925E+05	-2.04635106E+07	-2.25321289E+07
1.17000000E+00	-2.89214668E+07	-2.90141786E+07	2.68512248E+06	-1.96210933E+05	-2.04218203E+07	-2.25064282E+07
1.20000000E+00	-2.82320580E+07	-2.83925554E+07	2.77171546E+06	-2.09258655E+05	-2.03803306E+07	-2.24802598E+07
1.26000000E+00	-2.69260349E+07	-2.71544867E+07	2.92501525E+06	-2.36842210E+05	-2.02497670E+07	-2.23793319E+07
1.32000000E+00	-2.56134308E+07	-2.59272265E+07	3.08658707E+06	-2.63620889E+05	-2.01243253E+07	-2.22627546E+07
1.38000000E+00	-2.42964860E+07	-2.47083021E+07	3.25606591E+06	-2.88524669E+05	-2.00042252E+07	-2.21900973E+07
1.44000000E+00	-2.29778767E+07	-2.34956651E+07	3.43163386E+06	-3.11768162E+05	-1.98895885E+07	-2.21010780E+07
1.50000000E+00	-2.16605440E+07	-2.22875253E+07	3.61058962E+06	-3.34586162E+05	-1.97804385E+07	-2.20155131E+07
1.56000000E+00	-2.03475232E+07	-2.10821839E+07	3.78991767E+06	-3.58329190E+05	-1.96767006E+07	-2.19333173E+07
1.62000000E+00	-1.90417731E+07	-1.98778679E+07	3.96685872E+06	-3.84219044E+05	-1.95782015E+07	-2.18545038E+07
1.68000000E+00	-1.77460049E+07	-1.86725630E+07	4.13947722E+06	-4.12644346E+05	-1.94846698E+07	-2.17791843E+07
1.74000000E+00	-1.64625115E+07	-1.74638478E+07	4.30723268E+06	-4.42636038E+05	-1.93957360E+07	-2.17075688E+07
1.80000000E+00	-1.51929969E+07	-1.62487271E+07	4.47154822E+06	-4.71313180E+05	-1.93109322E+07	-2.16399659E+07
1.86000000E+00	-1.38177794E+07	-1.52228861E+07	4.68512994E+06	-5.40414203E+05	-1.89931999E+07	-2.13737273E+07
1.92000000E+00	-1.25362677E+07	-1.41059050E+07	4.88210937E+06	-5.71529783E+05	-1.87322369E+07	-2.10760971E+07
1.98000000E+00	-1.13280931E+07	-1.29317840E+07	5.05232970E+06	-5.98900557E+05	-1.85246065E+07	-2.08702867E+07
2.04000000E+00	-1.01680509E+07	-1.17237904E+07	5.20175363E+06	-6.05071895E+05	-1.83679523E+07	-2.07184261E+07
2.10000000E+00	-9.02797784E+06	-1.05063272E+07	5.34620553E+06	-6.16986937E+05	-1.82609974E+07	-2.06215637E+07
2.16000000E+00	-7.87862968E+06	-9.30174022E+06	5.50511371E+06	-6.22079815E+05	-1.82035449E+07	-2.05796662E+07
2.22000000E+00	-6.69155823E+06	-8.13315058E+06	5.69525249E+06	-6.19368744E+05	-1.81964775E+07	-2.05916185E+07
2.28000000E+00	-5.44068886E+06	-7.02628391E+06	5.92448450E+06	-6.16549159E+05	-1.82417579E+07	-2.06552243E+07
2.34000000E+00	-4.10569779E+06	-6.01129459E+06	6.18550275E+06	-6.36086843E+05	-1.83424288E+07	-2.07672051E+07
2.40000000E+00	-2.67088947E+05	-5.12459768E+06	6.44957294E+06	-7.21311066E+05	-1.85026124E+07	-2.09232013E+07
2.76000000E+00	4.25418560E+06	1.29321901E+06	7.45894376E+06	-9.51969956E+05	-1.63883563E+07	-1.87123691E+07
3.12000000E+00	1.05580300E+07	7.10619040E+06	8.48148943E+06	-1.11411401E+06	-1.45638034E+07	-1.67585894E+07
3.48000000E+00	1.62271553E+07	1.23067975E+07	9.47350282E+06	-1.23406097E+06	-1.29424966E+07	-1.49751610E+07
3.84000000E+00	2.12488466E+07	1.68882746E+07	1.03938555E+07	-1.33561779E+06	-1.14378752E+07	-1.32754869E+07

4.20000000E+00	2.56122488E+07	2.08455669E+07	1.12076185E+07	-1.43655501E+06	-9.96327381E+06	-1.15730747E+07
4.56000000E+00	2.93094530E+07	2.41788882E+07	1.18896834E+07	-1.54508113E+06	-8.43192331E+06	-9.78153582E+06
4.92000000E+00	3.23365828E+07	2.68837786E+07	1.24283832E+07	-1.65621707E+06	-6.75695027E+06	-7.81458647E+06
5.28000000E+00	3.46948803E+07	2.89731622E+07	1.28291130E+07	-1.74877046E+06	-4.85137718E+06	-5.58604691E+06
5.64000000E+00	3.63917928E+07	3.04579046E+07	1.31179512E+07	-1.78081011E+06	-2.62812235E+06	-3.00984177E+06
6.00000000E+00	3.74420585E+07	3.13579709E+07	1.33452800E+07	-1.68714036E+06	1.00081537E-05	1.12477024E-05
6.36000000E+00	3.63917928E+07	3.04579046E+07	1.31179512E+07	-1.78081011E+06	2.62812235E+06	3.00984177E+06
6.72000000E+00	3.46948803E+07	2.89731622E+07	1.28291130E+07	-1.74877046E+06	4.85137718E+06	5.58604691E+06
7.08000000E+00	3.23355828E+07	2.68837786E+07	1.24283832E+07	-1.65621707E+06	6.75695027E+06	7.81458647E+06
7.44000000E+00	2.93094530E+07	2.41788882E+07	1.18896834E+07	-1.54508113E+06	8.43192331E+06	9.78153582E+06
7.80000000E+00	2.56122488E+07	2.08456669E+07	1.12076185E+07	-1.43655501E+06	9.96327381E+06	1.15730747E+07
8.16000000E+00	2.12488466E+07	1.68882746E+07	1.03938555E+07	-1.33561779E+06	1.14378752E+07	1.32754869E+07
8.52000000E+00	1.62271853E+07	1.23067975E+07	9.47350282E+06	-1.23406097E+06	1.29424966E+07	1.49751610E+07
8.88000000E+00	1.05580300E+07	7.70619040E+06	8.48148943E+06	-1.11411401E+06	1.45638034E+07	1.67585854E+07
9.24000000E+00	4.25418560E+06	1.29321901E+06	7.45894376E+06	-9.51969956E+05	1.63883563E+07	1.87123691E+07
9.60000000E+00	-2.67088947E+06	-5.12459768E+06	6.44957294E+06	-7.21311656E+05	1.85026124E+07	2.09232013E+07
9.66000000E+00	-4.10569779E+06	-6.01129459E+06	6.18550275E+06	-6.36066843E+05	1.83424288E+07	2.07672051E+07
9.72000000E+00	-5.44098886E+06	-7.02628391E+06	5.92448450E+06	-5.16549159E+05	1.82417579E+07	2.06552243E+07
9.78000000E+00	-6.69155823E+06	-8.13315098E+06	5.69525249E+06	-6.19369744E+05	1.81964775E+07	2.05916185E+07
9.84000000E+00	-7.87852968E+06	-9.30174022E+06	5.50511371E+06	-6.22079815E+05	1.82035449E+07	2.05796662E+07
9.90000000E+00	-9.02797784E+06	-1.05063272E+07	5.34620553E+06	-6.16976937E+05	1.82609974E+07	2.06215637E+07
9.96000000E+00	-1.01690509E+07	-1.17237904E+07	5.20175363E+06	-6.05071835E+05	1.83679523E+07	2.07184261E+07
1.00200000E+01	-1.13280931E+07	-1.29317840E+07	5.05232970E+06	-5.99900567E+05	1.85246055E+07	2.08702867E+07
1.00800000E+01	-1.25362677E+07	-1.41069050E+07	4.88210937E+06	-5.71529783E+05	1.87322369E+07	2.10760971E+07
1.01400000E+01	-1.38177794E+07	-1.52229861E+07	4.68512994E+06	-5.40414203E+05	1.89931999E+07	2.13337273E+07
1.02000000E+01	-1.51929969E+07	-1.62487271E+07	4.47154822E+06	-4.71313130E+05	1.93109322E+07	2.16399659E+07
1.02600000E+01	-1.64625115E+07	-1.74639478E+07	4.30723268E+06	-4.42636039E+05	1.93957360E+07	2.17075688E+07
1.03200000E+01	-1.77460049E+07	-1.86725630E+07	4.13947722E+06	-4.12644346E+05	1.94866698E+07	2.17791843E+07
1.03800000E+01	-1.90417731E+07	-1.98778679E+07	3.96685872E+06	-3.84219044E+05	1.95782015E+07	2.18545038E+07
1.04400000E+01	-2.03475232E+07	-2.10821839E+07	3.78991787E+06	-3.58329190E+05	1.96767006E+07	2.19333173E+07
1.05000000E+01	-2.16605440E+07	-2.22875253E+07	3.61058962E+06	-3.34586162E+05	1.97804385E+07	2.20155131E+07
1.05600000E+01	-2.29778767E+07	-2.34956651E+07	3.43163386E+06	-3.11759152E+05	1.98885885E+07	2.21010780E+07
1.06200000E+01	-2.42964860E+07	-2.47083021E+07	3.25505591E+06	-2.88524658E+05	2.00042252E+07	2.21900973E+07
1.06800000E+01	-2.56134308E+07	-2.59272265E+07	3.08658707E+06	-2.63630889E+05	2.01243253E+07	2.22827546E+07
1.07400000E+01	-2.69260349E+07	-2.71544867E+07	2.92501525E+06	-2.36842210E+05	2.02497670E+07	2.23793319E+07
1.08000000E+01	-2.82320580E+07	-2.83925554E+07	2.77171546E+06	-2.09298655E+05	2.03803306E+07	2.24802098E+07
1.08300000E+01	-2.89214668E+07	-2.90141786E+07	2.68512248E+06	-1.96210933E+05	2.04218203E+07	2.25064282E+07
1.08600000E+01	-2.96048905E+07	-2.96395480E+07	2.59958993E+06	-1.85198926E+05	2.04635106E+07	2.25321289E+07
1.08900000E+01	-3.02838839E+07	-3.02669163E+07	2.51155516E+06	-1.75458236E+05	2.05053049E+07	2.25573806E+07
1.09200000E+01	-3.09600585E+07	-3.08945915E+07	2.43326651E+06	-1.66368517E+05	2.05471414E+07	2.25822173E+07
1.09500000E+01	-3.16350522E+07	-3.15209072E+07	2.35088389E+06	-1.57395507E+05	2.05889930E+07	2.26066381E+07
1.09800000E+01	-3.23104995E+07	-3.21441938E+07	2.26857944E+06	-1.47993059E+05	2.06308673E+07	2.26306074E+07
1.10100000E+01	-3.29880007E+07	-3.27627483E+07	2.19603809E+06	-1.37505172E+05	2.06728067E+07	2.26540548E+07
1.10400000E+01	-3.36690923E+07	-3.33748058E+07	2.10315824E+06	-1.25068025E+05	2.07148881E+07	2.26768752E+07
1.10700000E+01	-3.43552165E+07	-3.39785054E+07	2.02015233E+06	-1.19512009E+05	2.07572235E+07	2.26989286E+07
1.11000000E+01	-3.50476912E+07	-3.45718911E+07	1.93764746E+06	-8.92637571E+04	2.07999592E+07	2.27200402E+07
1.11300000E+01	-3.57391764E+07	-3.52095281E+07	1.85908833E+06	-7.95089055E+04	2.08448395E+07	2.27422856E+07
1.11600000E+01	-3.64499411E+07	-3.58271775E+07	1.77900250E+06	-6.03885434E+04	2.08885350E+07	2.27623320E+07
1.11900000E+01	-3.71727988E+07	-3.64312584E+07	1.70071939E+06	-3.27091133E+04	2.09313991E+07	2.27798444E+07
1.12200000E+01	-3.79003261E+07	-3.70276967E+07	1.62835791E+06	3.49413654E+03	2.09736422E+07	2.27946308E+07
1.12500000E+01	-3.86249868E+07	-3.76234002E+07	1.55641310E+06	4.85505437E+04	2.10153222E+07	2.28066421E+07
1.12800000E+01	-3.93392558E+07	-3.82236494E+07	1.51934269E+06	1.02753527E+05	2.10563943E+07	2.28159720E+07
1.13100000E+01	-4.00357433E+07	-3.88349489E+07	1.49115359E+06	1.65957650E+05	2.10966111E+07	2.28228573E+07
1.13400000E+01	-4.07073186E+07	-3.94637824E+07	1.48498898E+06	2.37176C82E+05	2.11356223E+07	2.28276775E+07
1.13700000E+01	-4.13472345E+07	-4.01170068E+07	1.50271389E+06	3.14178072E+05	2.11729251E+07	2.28305552E+07
1.14000000E+01	-4.19492508E+07	-4.08019731E+07	1.54450279E+06	3.93086406E+05	2.12078741E+07	2.28333559E+07
1.14300000E+01	-4.26110720E+07	-4.15467549E+07	1.57930648E+06	4.63802578E+05	2.12739235E+07	2.28686869E+07
1.14600000E+01	-4.31348149E+07	-4.23882454E+07	1.66316305E+06	5.12030593E+05	2.13333039E+07	2.29020556E+07
1.14900000E+01	-4.35275917E+07	-4.33260385E+07	1.78364512E+06	5.27843736E+05	2.13834027E+07	2.29356934E+07
1.15200000E+01	-4.37985848E+07	-4.43617438E+07	1.92142512E+06	4.94556675E+05	2.14216851E+07	2.29717536E+07
1.15500000E+01	-4.39589786E+07	-4.54499205E+07	2.05050135E+06	3.85145609E+05	2.14456945E+07	2.30123113E+07
1.15800000E+01	-4.40218920E+07	-4.67430113E+07	2.13842411E+06	1.92068407E+05	2.14530522E+07	2.30593633E+07
1.16100000E+01	-4.40023106E+07	-4.81012761E+07	2.14652175E+06	-1.52115251E+05	2.14414575E+07	2.31148285E+07
1.16400000E+01	-4.39170186E+07	-4.95827266E+07	2.03012630E+06	-6.84723732E+05	2.14086878E+07	2.31805475E+07
1.16700000E+01	-4.37845312E+07	-5.11980595E+07	1.73880206E+06	-1.43269331E+06	2.13525985E+07	2.32582626E+07
1.17000000E+01	-4.36250266E+07	-5.29595910E+07	1.21656664E+06	-2.45835801E+06	2.12711232E+07	2.33497183E+07
1.17300000E+01	-4.36100655E+07	-5.38554858E+07	3.63099109E+05	-3.50604649E+06	2.11714306E+07	2.34533559E+07
1.17600000E+01	-4.38182218E+07	-5.47021966E+07	-8.78530735E+05	-4.85235483E+06	2.10017925E+07	2.35054382E+07
1.17900000E+01	-4.46374960E+07	-5.51227821E+07	-2.64626512E+06	-6.40620399E+06	2.07688613E+07	2.34989C79E+07
1.18200000E+01	-4.64464612E+07	-5.47351217E+07	-5.04662225E+06	-8.04591784E+06	2.04872816E+07	2.34187021E+07
1.18500000E+01	-4.96073161E+07	-5.31401509E+07	-8.13153817E+06	-9.59667451E+06	2.01796901E+07	2.32417526E+07
1.18800000E+01	-5.44589372E+07	-4.99160971E+07	-1.18752086E+07	-1.08075577E+07	1.98767160E+07	2.29369852E+07
1.19100000E+01	-6.13099314E+07	-4.46117148E+07	-1.61509309E+07	-1.13310079E+07	1.96169805E+07	2.24653207E+07
1.19400000E+01	-7.04316888E+07	-3.67355267E+07	-2.07079458E+07	-1.05962739E+07	1.94470970E+07	2.17796738F+07
1.19700000E+01	-8.20514349E+07	-2.57690296E+07	-2.51482794E+07	-8.29086395E+06	1.94216713E+07	2.08249542E+07
1.20000000E+01	-9.63452835E+07	-1.11199853E+07	-2.89035851E+07	-3.33599630E+06	1.96033012E+07	1.95380656E+07

TABLE VII.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 1 - Concluded

(h) Stress and moment resultants corresponding to the lowest frequency of cylinder

STRESS AND MOMENT RESULTANTS CORRESPONDING TO FREQUENCY 1

X	T1	T2	T12	M1	M2	M12
0.	-5.37326364E+05	-1.61197909E+05	-1.95706826E+05	-7.10210785E+02	-2.13063235E+02	-2.17452029E+00
3.00000000E-02	-5.39102247E+05	-1.67195466E+05	-2.01226993E+05	-4.69025049E+02	-1.40495145E+02	2.22700859E+01
6.00000000E-02	-5.35855784E+05	-1.57020220E+05	-2.06123841E+05	-2.80766446E+02	-8.34191961E+01	3.77310910E+01
9.00000000E-02	-5.29607710E+05	-1.37407958E+05	-2.10399337E+05	-1.39132141E+02	-4.01004793E+01	4.63033817E+01
1.20000000E-01	-5.21874360E+05	-1.13413124E+05	-2.14055449E+05	-3.78174887E+01	-8.76205221E+00	4.98152154E+01
1.50000000E-01	-5.13736222E+05	-8.86373520E+04	-2.17094145E+05	2.95002533E+01	1.24093479E+01	4.98282207E+01
1.80000000E-01	-5.05906506E+05	-6.54580055E+04	-2.19517391E+05	6.91512085E+01	2.52575904E+01	4.76373969E+01
2.10000000E-01	-4.98799703E+05	-4.52567196E+04	-2.21327155E+05	8.74729688E+01	3.16514383E+01	4.42711146E+01
2.40000000E-01	-4.92600145E+05	-2.86479385E+04	-2.22525404E+05	9.08088798E+01	3.34788339E+01	4.04911149E+01
2.70000000E-01	-4.87330572E+05	-1.57074547E+04	-2.23114106E+05	8.55063271E+01	3.26411861E+01	3.67925101E+01
3.00000000E-01	-4.82920686E+05	-6.20094812E+03	-2.23095228E+05	7.79150221E+01	3.10476565E+01	3.34037834E+01
3.30000000E-01	-4.74910350E+05	1.53921992E+03	-2.23046147E+05	6.19112744E+01	2.68687020E+01	3.05222094E+01
3.60000000E-01	-4.67495937E+05	6.73631150E+03	-2.22938475E+05	4.73488268E+01	2.30724011E+01	2.82924037E+01
3.90000000E-01	-4.60514970E+05	9.93191296E+03	-2.22774139E+05	3.42936479E+01	1.96906484E+01	2.66518415E+01
4.20000000E-01	-4.53821385E+05	1.16129023E+04	-2.22555066E+05	2.28112958E+01	1.67539709E+01	2.55353950E+01
4.50000000E-01	-4.47286201E+05	1.22092181E+04	-2.22283184E+05	1.29669019E+01	1.42914721E+01	2.48753332E+01
4.80000000E-01	-4.40798187E+05	1.20916280E+04	-2.21960418E+05	4.82515353E+00	1.23307761E+01	2.46013219E+01
5.10000000E-01	-4.34264535E+05	1.15694980E+04	-2.21588696E+05	-1.54972245E+00	1.08979722E+01	2.46404242E+01
5.40000000E-01	-4.27611524E+05	1.08885607E+04	-2.21169945E+05	-6.09397638E+00	1.00175585E+01	2.49170996E+01
5.70000000E-01	-4.20785193E+05	1.02286845E+04	-2.20706091E+05	-8.74435258E+00	9.71238686E+00	2.53532051E+01
6.00000000E-01	-4.13752011E+05	9.70164196E+03	-2.20199063E+05	-9.43810611E+00	1.00036066E+01	2.58679940E+01
6.30000000E-01	-4.07316927E+05	9.09872358E+03	-2.20012179E+05	-1.01316764E+01	1.03052003E+01	2.64115036E+01
6.60000000E-01	-4.00851052E+05	8.62566848E+03	-2.19809134E+05	-1.02447914E+01	1.07918092E+01	2.69797163E+01
6.90000000E-01	-3.94348831E+05	8.30099110E+03	-2.19589835E+05	-9.89069346E+00	1.14297216E+01	2.75507837E+01
7.20000000E-01	-3.87809715E+05	8.12651838E+03	-2.19354186E+05	-9.18275036E+00	1.21848085E+01	2.81076168E+01
7.50000000E-01	-3.81236940E+05	8.09146968E+03	-2.19102095E+05	-8.23442428E+00	1.30226257E+01	2.86378868E+01
7.80000000E-01	-3.74636297E+05	8.17653652E+03	-2.18833465E+05	-7.15924137E+00	1.39085159E+01	2.91340243E+01
8.10000000E-01	-3.68014913E+05	8.35796245E+03	-2.18548204E+05	-6.07076115E+00	1.48077104E+01	2.95932200E+01
8.40000000E-01	-3.61380026E+05	8.61162289E+03	-2.18246216E+05	-5.08254591E+00	1.56854316E+01	3.00174243E+01
8.70000000E-01	-3.54737760E+05	8.91710492E+03	-2.17927408E+05	-4.30813010E+00	1.65069944E+01	3.04133473E+01
9.00000000E-01	-3.48091901E+05	9.26178714E+03	-2.17591686E+05	-3.86098974E+00	1.72379087E+01	3.07924591E+01
9.30000000E-01	-3.41662469E+05	9.57373893E+03	-2.17272359E+05	-3.03661243E+00	1.80892473E+01	3.11546352E+01
9.60000000E-01	-3.35213127E+05	9.91166457E+03	-2.16950332E+05	-2.35123647E+00	1.89057204E+01	3.14944568E+01
9.90000000E-01	-3.28747176E+05	1.02645613E+04	-2.16625743E+05	-1.77740603E+00	1.96951828E+01	3.18172775E+01
1.02000000E+00	-3.22266690E+05	1.06255186E+04	-2.16298732E+05	-1.28763455E+00	2.04655918E+01	3.21272922E+01
1.05000000E+00	-3.15772812E+05	1.09907251E+04	-2.15969440E+05	-8.54412777E-01	2.12249821E+01	3.24275376E+01
1.08000000E+00	-3.09266054E+05	1.13584760E+04	-2.15638006E+05	-4.50213624E-01	2.19814410E+01	3.27198918E+01
1.11000000E+00	-3.02746593E+05	1.17281797E+04	-2.15304569E+05	-4.75046660E-02	2.27430838E+01	3.30050747E+01
1.14000000E+00	-2.96214570E+05	1.20993652E+04	-2.14969271E+05	3.81249425E-01	2.35180286E+01	3.32826474E+01
1.17000000E+00	-2.89670388E+05	1.24706889E+04	-2.14632250E+05	8.63576934E-01	2.43143719E+01	3.35510130E+01
1.20000000E+00	-2.83115010E+05	1.28389418E+04	-2.14293646E+05	1.42699216E+00	2.51401635E+01	3.38074158E+01
1.26000000E+00	-2.70394110E+05	1.34691923E+04	-2.13136317E+05	1.99035980E+00	2.66374619E+01	3.43086050E+01
1.32000000E+00	-2.57694341E+05	1.41445985E+04	-2.12026103E+05	2.69868720E+00	2.81975604E+01	3.47958459E+01
1.38000000E+00	-2.45014542E+05	1.48690344E+04	-2.10962203E+05	3.51270237E+00	2.98079278E+01	3.52591358E+01
1.44000000E+00	-2.32357852E+05	1.56320365E+04	-2.09943818E+05	4.39302576E+00	3.14556744E+01	3.56917499E+01
1.50000000E+00	-2.19730024E+05	1.64144228E+04	-2.08970147E+05	5.30021247E+00	3.31276923E+01	3.60902417E+01
1.56000000E+00	-2.07137745E+05	1.71939127E+04	-2.08040389E+05	6.19479432E+00	3.48107966E+01	3.64544427E+01
1.62000000E+00	-1.94586940E+05	1.79507465E+04	-2.07153746E+05	7.03732208E+00	3.64918650E+01	3.67874624E+01
1.68000000E+00	-1.82081097E+05	1.86733050E+04	-2.06309415E+05	7.78840752E+00	3.81579789E+01	3.70956885E+01
1.74000000E+00	-1.69619573E+05	1.93637290E+04	-2.05506598E+05	8.40876567E+00	3.97965637E+01	3.73887868E+01
1.80000000E+00	-1.57195911E+05	2.00435391E+04	-2.04744494E+05	8.85925687E+00	4.13955292E+01	3.76797010E+01
1.86000000E+00	-1.45190130E+05	2.07675715E+04	-2.01624596E+05	1.17680912E+01	4.37424300E+01	3.78885963E+01
1.92000000E+00	-1.33202196E+05	2.15985248E+04	-1.99031619E+05	1.31450126E+01	4.56347758E+01	3.79585485E+01
1.98000000E+00	-1.21285207E+05	2.23594087E+04	-1.96964411E+05	1.34178473E+01	4.71977735E+01	3.80003649E+01
2.04000000E+00	-1.09444536E+05	2.30323107E+04	-1.95421819E+05	1.30156148E+01	4.85606070E+01	3.80888288E+01
2.10000000E+00	-9.76563610E+04	2.36966396E+04	-1.94402692E+05	1.23680643E+01	4.98548931E+01	3.82626987E+01
2.16000000E+00	-8.58861895E+04	2.44673697E+04	-1.93905878E+05	1.19052121E+01	5.12131381E+01	3.85247090E+01
2.22000000E+00	-7.41073863E+04	2.54332845E+04	-1.93930223E+05	1.20568777E+01	5.27671931E+01	3.88415695E+01
2.28000000E+00	-6.23197005E+04	2.65952211E+04	-1.94474577E+05	1.32522212E+01	5.46467108E+01	3.91439659E+01
2.34000000E+00	-5.05677918E+04	2.78043132E+04	-1.95537787E+05	1.59192798E+01	5.69776012E+01	3.93265592E+01
2.40000000E+00	-3.89557578E+04	2.87002358E+04	-1.97118701E+05	2.04845049E+01	5.98804880E+01	3.92479861E+01
2.76000000E+00	2.77576896E+04	3.26037575E+04	-1.75493693E+05	2.46968954E+01	7.01648602E+01	3.77585247E+01
3.12000000E+00	8.83446188E+04	3.69152659E+04	-1.56602595E+05	2.87747996E+01	7.99949266E+01	3.57096994E+01
3.48000000E+00	1.42655949E+05	4.12844937E+04	-1.39579619E+05	3.26681798E+01	8.92248029E+01	3.31022473E+01
3.84000000E+00	1.90714236E+05	4.53866216E+04	-1.23558977E+05	3.63271888E+01	9.77092416E+01	2.99403794E+01
4.20000000E+00	2.32320387E+05	4.89580116E+04	-1.07674881E+05	3.97024387E+01	1.05304524E+02	2.62317811E+01

4.56000000E+00	2.67464385E+05	5.18319401E+04	-9.10615421E+04	4.27452681E+01	1.11869355E+02	2.19876116E+01
4.92000000E+00	2.96136007E+05	5.39743314E+04	-7.28531728E+04	4.54080106E+01	1.17265756E+02	1.72225043E+01
5.28000000E+00	3.18375546E+05	5.55194909E+04	-5.21839847E+04	4.76442628E+01	1.21359956E+02	1.19545666E+01
5.64000000E+00	3.34284527E+05	5.68058390E+04	-2.81881899E+04	4.94091518E+01	1.24023289E+02	6.20537994E+00
6.00000000E+00	3.44036431E+05	5.84116434E+04	6.05669361E-08	5.06596040E+01	1.25133084E+02	-1.87241960E-11
6.36000000E+00	3.34284527E+05	5.68058390E+04	2.81881899E+04	4.94091518E+01	1.24023289E+02	-6.20537994E+00
6.72000000E+00	3.18375546E+05	5.55194909E+04	5.21839847E+04	4.76442628E+01	1.21359956E+02	-1.19545666E+01
7.08000000E+00	2.96136007E+05	5.39743314E+04	7.28531728E+04	4.54080106E+01	1.17265756E+02	-1.72225043E+01
7.44000000E+00	2.67464385E+05	5.18319401E+04	9.10615421E+04	4.27452681E+01	1.11869355E+02	-2.19876116E+01
7.80000000E+00	2.32320387E+05	4.89580116E+04	1.07674881E+05	3.97024387E+01	1.05304524E+02	-2.62317811E+01
8.16000000E+00	1.90714236E+05	4.53866216E+04	1.23558977E+05	3.63271888E+01	9.77092416E+01	-2.99403794E+01
8.52000000E+00	1.42695949E+05	4.12844937E+04	1.39579619E+05	3.26681798E+01	8.92248029E+01	-3.31022473E+01
8.88000000E+00	8.83446188E+04	3.69152659E+04	1.56602595E+05	2.87747996E+01	7.99949266E+01	-3.57096994E+01
9.24000000E+00	2.77576896E+04	3.26037575E+04	1.75493693E+05	2.46968954E+01	7.01648602E+01	-3.77585247E+01
9.60000000E+00	-3.89597578E+04	2.87002358E+04	1.97118701E+05	2.04845049E+01	5.98804880E+01	-3.92479861E+01
9.66000000E+00	-5.05677918E+04	2.78043132E+04	1.95537787E+05	1.59192798E+01	5.69776012E+01	-3.93265592E+01
9.72000000E+00	-6.23197005E+04	2.65952211E+04	1.94474577E+05	1.32522212E+01	5.46467108E+01	-3.91439659E+01
9.78000000E+00	-7.41073863E+04	2.54332845E+04	1.93930223E+05	1.20568777E+01	5.27671931E+01	-3.88415695E+01
9.84000000E+00	-8.58861895E+04	2.44673697E+04	1.93905878E+05	1.19052121E+01	5.12131381E+01	-3.85247090E+01
9.90000000E+00	-9.76563610E+04	2.36966396E+04	1.94402692E+05	1.23680643E+01	4.98548931E+01	-3.82626987E+01
9.96000000E+00	-1.09444536E+05	2.30323107E+04	1.95421819E+05	1.30156148E+01	4.85606070E+01	-3.80888288E+01
1.00200000E+01	-1.21285207E+05	2.23594087E+04	1.96964411E+05	1.34178473E+01	4.71977735E+01	-3.80003649E+01
1.00800000E+01	-1.33202196E+05	2.15985248E+04	1.99031619E+05	1.31450126E+01	4.56347758E+01	-3.79585485E+01
1.01400000E+01	-1.45190130E+05	2.07675715E+04	2.01624596E+05	1.17680912E+01	4.37424300E+01	-3.78885963E+01
1.02000000E+01	-1.57195911E+05	2.00435391E+04	2.04744494E+05	8.85925687E+00	4.13955292E+01	-3.76797010E+01
1.02600000E+01	-1.69619573E+05	1.93637290E+04	2.05506598E+05	8.40876567E+00	3.97965637E+01	-3.73887868E+01
1.03200000E+01	-1.82081097E+05	1.86733050E+04	2.06309415E+05	7.78840753E+00	3.81579789E+01	-3.70956885E+01
1.03800000E+01	-1.94586940E+05	1.79507465E+04	2.07153746E+05	7.03732208E+00	3.64918650E+01	-3.67874624E+01
1.04400000E+01	-2.07137745E+05	1.71939127E+04	2.08040389E+05	6.19479432E+00	3.48107966E+01	-3.64544427E+01
1.05000000E+01	-2.19730024E+05	1.64144228E+04	2.08970147E+05	5.30021247E+00	3.31276923E+01	-3.60902417E+01
1.05600000E+01	-2.32357852E+05	1.56320365E+04	2.09943818E+05	4.39302576E+00	3.14556744E+01	-3.56917499E+01
1.06200000E+01	-2.45014542E+05	1.48690344E+04	2.10962203E+05	3.51270237E+00	2.98079278E+01	-3.52591358E+01
1.06800000E+01	-2.57694341E+05	1.41445985E+04	2.12026103E+05	2.69868720E+00	2.81975604E+01	-3.47958459E+01
1.07400000E+01	-2.70394110E+05	1.34691923E+04	2.13136317E+05	1.99035980E+00	2.66374619E+01	-3.43086050E+01
1.08000000E+01	-2.83115010E+05	1.28389418E+04	2.14293646E+05	1.42699216E+00	2.51401635E+01	-3.38074158E+01
1.08300000E+01	-2.89670388E+05	1.24706889E+04	2.14632250E+05	8.63576934E-01	2.43143719E+01	-3.35510130E+01
1.08600000E+01	-2.96214570E+05	1.20993652E+04	2.14969271E+05	3.81249425E-01	2.35180286E+01	-3.32826474E+01
1.08900000E+01	-3.02746593E+05	1.17281797E+04	2.15304569E+05	-4.75046659E-02	2.27430838E+01	-3.30050747E+01
1.09200000E+01	-3.09266054E+05	1.13584760E+04	2.15638006E+05	-4.50213624E-01	2.19814410E+01	-3.27198918E+01
1.09500000E+01	-3.15772812E+05	1.09907251E+04	2.15969440E+05	-8.54412277E-01	2.12249821E+01	-3.24275376E+01
1.09800000E+01	-3.22266690E+05	1.06255186E+04	2.16298732E+05	-1.28763455E+00	2.04655918E+01	-3.21272922E+01
1.10100000E+01	-3.28747176E+05	1.02645613E+04	2.16625743E+05	-1.77740603E+00	1.96951828E+01	-3.18172775E+01
1.10400000E+01	-3.35213127E+05	9.91166457E+03	2.16950332E+05	-2.35123647E+00	1.89057204E+01	-3.14944568E+01
1.10700000E+01	-3.41662469E+05	9.57373893E+03	2.17272359E+05	-3.03661243E+00	1.80892473E+01	-3.11546352E+01
1.11000000E+01	-3.48091901E+05	9.26178714E+03	2.17591686E+05	-3.86098974E+00	1.72379087E+01	-3.07924591E+01
1.11300000E+01	-3.54737760E+05	8.91710492E+03	2.17927408E+05	-4.30813010E+00	1.65069944E+01	-3.04133473E+01
1.11600000E+01	-3.61380026E+05	8.61162289E+03	2.18246216E+05	-5.08254591E+00	1.56854316E+01	-3.00174243E+01
1.11900000E+01	-3.68014913E+05	8.35796245E+03	2.18548204E+05	-6.07076115E+00	1.48077104E+01	-2.95932200E+01
1.12200000E+01	-3.74636297E+05	8.17653652E+03	2.18833465E+05	-7.15924137E+00	1.39085159E+01	-2.91340243E+01
1.12500000E+01	-3.81236940E+05	8.09146968E+03	2.19102095E+05	-8.23442428E+00	1.30226257E+01	-2.86378868E+01
1.12800000E+01	-3.87809715E+05	8.12651838E+03	2.19354186E+05	-9.18275036E+00	1.21848085E+01	-2.81076168E+01
1.13100000E+01	-3.94348831E+05	8.30099110E+03	2.19589835E+05	-9.89069346E+00	1.14297216E+01	-2.75507837E+01
1.13400000E+01	-4.00851052E+05	8.62566848E+03	2.19809134E+05	-1.02447914E+01	1.07918092E+01	-2.69797163E+01
1.13700000E+01	-4.07316927E+05	9.09872358E+03	2.20012179E+05	-1.01316764E+01	1.03052003E+01	-2.64115036E+01
1.14000000E+01	-4.13752011E+05	9.70164196E+03	2.20199063E+05	-9.43810611E+00	1.00036066E+01	-2.58679940E+01
1.14300000E+01	-4.20785193E+05	1.02286845E+04	2.20706091E+05	-8.74435258E+00	9.71238686E+00	-2.53532051E+01
1.14600000E+01	-4.27611524E+05	1.08885607E+04	2.21169945E+05	-6.09397638E+00	1.00175585E+01	-2.49170996E+01
1.14900000E+01	-4.34264535E+05	1.15694980E+04	2.21588696E+05	-1.54972245E+00	1.08979722E+01	-2.46404242E+01
1.15200000E+01	-4.40798187E+05	1.20916280E+04	2.21960418E+05	4.82515353E+00	1.23307761E+01	-2.46013219E+01
1.15500000E+01	-4.47286201E+05	1.22092181E+04	2.22283184E+05	1.29669019E+01	1.42914721E+01	-2.48753332E+01
1.15800000E+01	-4.53821385E+05	1.16129023E+04	2.22555066E+05	2.28112958E+01	1.67539709E+01	-2.55353950E+01
1.16100000E+01	-4.60514970E+05	9.93191296E+03	2.22774139E+05	3.42936479E+01	1.96906484E+01	-2.66518415E+01
1.16400000E+01	-4.67495937E+05	6.73631150E+03	2.22938475E+05	4.73488268E+01	2.30724011E+01	-2.82924037E+01
1.16700000E+01	-4.74910350E+05	1.53921992E+03	2.23046147E+05	6.19112744E+01	2.68687020E+01	-3.05222094E+01
1.17000000E+01	-4.82920686E+05	-6.20094812E+03	2.23095228E+05	7.79150221E+01	3.10476565E+01	-3.34037834E+01
1.17300000E+01	-4.87330572E+05	-1.57074547E+04	2.23114106E+05	8.55063271E+01	3.26411861E+01	-3.67925101E+01
1.17600000E+01	-4.92600145E+05	-2.86479385E+04	2.22525404E+05	9.08088798E+01	3.34788339E+01	-4.04911149E+01
1.17900000E+01	-4.98799703E+05	-4.52567196E+04	2.21327155E+05	8.74729688E+01	3.16514383E+01	-4.42711146E+01
1.18200000E+01	-5.05906506E+05	-6.54580055E+04	2.19517391E+05	6.91512085E+01	2.52575904E+01	-4.76373969E+01
1.18500000E+01	-5.13736222E+05	-8.86373520E+04	2.17094145E+05	2.95002533E+01	1.24093479E+01	-4.98282207E+01
1.18800000E+01	-5.21874360E+05	-1.13413124E+05	2.14055449E+05	-3.78174887E+01	-8.76205221E+00	-4.98152154E+01
1.19100000E+01	-5.29607710E+05	-1.37407958E+05	2.10399337E+05	-1.39132141E+02	-4.01004793E+01	-4.63033817E+01
1.19400000E+01	-5.35855784E+05	-1.57020220E+05	2.06123841E+05	-2.80746646E+02	-8.34191961E+01	-3.77310910E+01
1.19700000E+01	-5.39102247E+05	-1.67195466E+05	2.01226993E+05	-4.69025049E+02	-1.40495145E+02	-2.22700859E+01
1.20000000E+01	-5.37326364E+05	-1.61197909E+05	1.95706826E+05	-7.10210785E+02	-2.13063235E+02	2.17452029E+00

TABLE VIII.- CODING SHEETS FOR INPUT FOR SAMPLE CALCULATION 2

PROGRAM NO._____ DATE_____
CODED BY_____ PAGE_____ OF_____
DIVISION_____ SECTION_____ JOB ORDER_____ TASK NO._____

LANGLEY RESEARCH CENTER
FORTRAN - DATA CODING FORM

STATEMENT NUMBER (1 2 3 4 5)	CONTINUATION (6)	FORTRAN STATEMENT (7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72)	IDENTIFICATION AND SEQUENCING (73 74 75 76 77 78 79 80)
		SAMPLE CASE 2. CLAMPED-FREE 60-DEGREE CONE WITH THREE RINGS	
		0 2 1.0 0 7 3 0	
		0 0 0 0 0 0 0	
		3.464 1 1 9 8.	
		1.1547 0 6 6. 2.309401 32 2.309401 32 2.309401 32 2.309401 32	
		2.3094 1 3 2. 2.309401 32 2.309401 32 2.309401 32 2.309401 32	
		2.3094 1 3 2.	
		1.0000 0 0 0.0 1 0.0 0 0 0 0 0 0.0 .315 .315 .000254	
		.025 3 8.5 6 1.5 3.8	
		2	
		0.0 .245317 .525 -60.0 3.27917.211	
		9.6467 1 2 4. 5 5 1.3 9.7 6 1. 0.0 0.0 1.154706.6	
		1.65.2 0.0 0.0 0.0 1.463.5064	
		-.0125 2.9329547 00-05 0.0 0.0 0.0	
		0.0	
		7	
		0.0 -.497956 .317517 -6.0.0 2.49212.	
		1.7037 0. -5.2855. 0.0 0.0 9.54720.0.	
		3.477.1 0.0 0.0 0.0 3.27.1.9428	
		-.0125 .00002425 0.0 0.0 0.0	
		0.0	
		12	
		0.0 -.497956 .317517 -6.0.0 2.49212.	
		1.7037 0. -5.2855. 0.0 0.0 9.54720.0.	
		3.477.1 0.0 0.0 0.0 3.27.1.9428	

NASA-Langley Form 67 (MAR 69)

NOTE: WRITE NUMBERS 10, LETTERS I Ø U G Z C, SYMBOLS / . , *

TABLE VIII.- CODING SHEETS FOR INPUT FOR SAMPLE CALCULATION 2 - Concluded

PROGRAM NO._____
CODED BY_____
DIVISION_____SECTION_____

LANGLEY RESEARCH CENTER
FORTRAN - DATA CODING FORM

DATE_____
PAGE_____OF_____
JOB ORDER_____TASK NO._____

STATEMENT NUMBER (1 2 3 4 5)	CONTINUATION (6)	FORTRAN STATEMENT (7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72)	IDENTIFICATION AND SEQUENCING (73 74 75 76 77 78 79 80)
-.01.25		.0.0.0.2.4.2.5 0.0 0.0 0.0	
0.0			
		PI=3.1.4.1.5.9.2.6.5.3.5.8.9.7.9	
		RP=SIN(PI/3.)	
		R=S*RP	
		R1=0.0	
		R1P=0.0	
		R2=COS(PI/3.)/R	
		C1.1=YOUNG1*TH/(1.0-XMU1**2)	
		C1.2=XMU1*C1.1	
		C2.2=C1.1	
		C66=YOUNG1*TH/(2.0*(1.0+XMU1))	
		D1.1=YOUNG1*TH**3/(12.0*(1.0-XMU1**2))	
		D1.2=XMU1*D1.1	
		D2.2=D1.1	
		D66=YOUNG1*TH**3/(6.0*(1.0+XMU1))	
		K1.1=0.0	
		K1.2=0.0	
		K2.2=0.0	
		K66=0.0	

NASA-Langley Form 67 (MAR 69)

NOTE: WRITE NUMBERS IO, LETTERS I Ø U G Z C, SYMBOLS / . , *

TABLE IX.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 2

(a) Idealization parameters and material properties for ring-stiffened cone

SAMPLE CASE 2 CLAMPED-FREE 60-DEGREE CONE WITH THREE RINGS

K	NBEG	NLAST	ININ	ICASE	NRING	IPRINT
11	0	2	100	7	3	0

NMODE	ISTRN	ISTRES	IINT	IPLOT	IPLSTS	IFUNCT
0	0	0	0	0	0	0

	EPSILON (K)	S (K)
1	1.15470660E+00	4.04147310E+00
2	2.30941320E+00	5.77353300E+00
3	2.30941320E+00	8.08294620E+00
4	2.30941320E+00	1.03923594E+01
5	2.30941320E+00	1.27017726E+01
6	2.30941320E+00	1.50111858E+01
7	2.30941320E+00	1.73205990E+01
8	2.30941320E+00	1.96300122E+01
9	2.30941320E+00	2.19394254E+01
10	2.30941320E+00	2.42488386E+01
11	2.30941320E+00	2.65582518E+01

S SUB 0 =	3.46411980E+00
YOUNGS MODULUS 1 =	1.00000000E+07
YOUNGS MODULUS 2 =	1.00000000E+07
POISSONS RATIO 1 =	3.15000000E-01
POISSONS RATIO 2 =	3.15000000E-01
RHO =	2.54000000E-04
THICKNESS =	2.50000000E-02
G SUB 12 =	3.85615380E+06

INPUT DATA FOR RINGS

RING	JUNC	PSI HAT	XI 1 HAT	XI 3 HAT	PHI	E I 1	E I 3
1	2	0.	2.45370000E-01	5.25000000E-01	-6.00000000E+01	3.27972110E+04	9.64671240E+04
2	7	0.	-4.97956000E-01	3.17517000E-01	-6.00000000E+01	2.49220000E+04	1.70370000E+05
3	12	0.	-4.97956000E-01	3.17517000E-01	-6.00000000E+01	2.49220000E+04	1.70370000E+05

RING	E I 13	E GAMMA 1	E GAMMA 2	E A	E GAMMA 3	E GAMMA 4
1	5.51397610E+04	0.	0.	1.15470660E+06	1.65200000E+02	0.
2	-5.28550000E+04	0.	0.	9.54720000E+05	3.47710000E+03	0.
3	-5.28550000E+04	0.	0.	9.54720000E+05	3.47710000E+03	0.

RING	E GAMMA 5	E GAMMA 6	G J	Z	M 1	M 1 * XI BAR 3
1	0.	0.	1.46350640E+03	-1.25000000E-02	2.93295470E-05	0.
2	0.	0.	3.27194280E+02	-1.25000000E-02	2.42500000E-05	0.
3	0.	0.	3.27194280E+02	-1.25000000E-02	2.42500000E-05	0.

RING	M 1 * XI BAR 1	M 2	M 3
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.

CLAMPED-FREE BOUNDARY CONDITION - FIRST 4 ROWS AND COLUMNS DELETED

TABLE IX.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 2 - Continued

(b) Natural frequencies for circumferential wave number n = 0 for the ring-stiffened cone

N = 0

FOR RING 1, RADIUS A = 3.46877100E+00

FOR RING 2, RADIUS A = 1.36763065E+01

FOR RING 3, RADIUS A = 2.36763590E+01

	EIGENVALUES	OMEGA	FREQUENCY
1	1.54682372E+06	1.24371368E+03	1.97943180E+02
2	6.20396952E+06	2.49077689E+03	3.96419454E+02
3	1.45682366E+07	3.81683594E+03	6.07468307E+02
4	2.32162460E+07	4.81832398E+03	7.66860079E+02
5	2.63196124E+07	5.13026436E+03	8.16506932E+02
6	3.00898199E+07	5.48541884E+03	8.73031524E+02
7	3.51641116E+07	5.92993352E+03	9.43778232E+02
8	4.18929752E+07	6.47247829E+03	1.03012691E+03
9	5.27568541E+07	7.26339136E+03	1.15600464E+03
10	6.09263155E+07	7.80553108E+03	1.24228886E+03
11	7.21375654E+07	8.49338362E+03	1.35176399E+03
12	8.15316400E+07	9.02948725E+03	1.43708753E+03
13	9.74319713E+07	9.87076346E+03	1.57098080E+03
14	9.78921256E+07	9.89404495E+03	1.57468616E+03
15	1.05242619E+08	1.02587825E+04	1.63273595E+03
16	1.24003757E+08	1.11356974E+04	1.77230129E+03
17	1.41798023E+08	1.19078975E+04	1.89520075E+03
18	1.52236448E+08	1.23384135E+04	1.96371950E+03
19	1.81940682E+08	1.34885389E+04	2.14676764E+03
20	1.96325806E+08	1.40116311E+04	2.23002035E+03
21	2.20485684E+08	1.48487603E+04	2.36325361E+03
22	2.55822356E+08	1.59944477E+04	2.54559541E+03
23	2.69269923E+08	1.64094462E+04	2.61164447E+03
24	2.92397719E+08	1.70996409E+04	2.72149238E+03
25	3.35356749E+08	1.83127483E+04	2.91456441E+03
26	3.55490444E+08	1.88544542E+04	3.00077959E+03
27	3.69202593E+08	1.92146453E+04	3.05810577E+03
28	3.81443568E+08	1.95305803E+04	3.10838840E+03
29	4.44457957E+08	2.10821715E+04	3.35533181E+03
30	4.96011283E+08	2.22713108E+04	3.54458920E+03
31	5.48387909E+08	2.34176837E+04	3.72704011E+03
32	5.92980873E+08	2.43511986E+04	3.87561363E+03
33	6.87318685E+08	2.62167634E+04	4.17252749E+03
34	7.31767047E+08	2.70511931E+04	4.30533109E+03
35	9.44092234E+08	3.07260839E+04	4.89020814E+03
36	1.22309264E+09	3.49727414E+04	5.56608467E+03
37	1.83934710E+09	4.28876101E+04	6.82577515E+03
38	1.95279961E+09	4.41904923E+04	7.03313529E+03
39	2.12536343E+09	4.61016641E+04	7.33730773E+03
40	3.50629393E+09	5.92139673E+04	9.42419560E+03
41	4.73820259E+09	6.88346032E+04	1.09553674E+04
42	5.47717117E+09	7.40079129E+04	1.17787252E+04
43	6.64019314E+09	8.14873802E+04	1.29691194E+04
44	6.87857382E+09	8.29371679E+04	1.31998602E+04
45	8.72368976E+09	9.34006947E+04	1.48651822E+04
46	1.09629256E+10	1.04703990E+05	1.66641576E+04
47	1.26418077E+10	1.12435794E+05	1.78947123E+04
48	1.28624058E+10	1.13412547E+05	1.80501675E+04
49	1.87723453E+10	1.37012209E+05	2.18061703E+04
50	1.88369246E+10	1.37247676E+05	2.18436461E+04
51	2.08853140E+10	1.44517521E+05	2.30006779E+04
52	2.58747540E+10	1.60856315E+05	2.56010776E+04
53	2.91603427E+10	1.70763997E+05	2.71779342E+04
54	3.19991597E+10	1.78883089E+05	2.84701279E+04
55	3.58399698E+10	1.89314473E+05	3.01303342E+04
56	4.18643727E+10	2.04607851E+05	3.25643509E+04

57	4.59814396E+10	2.14432832E+05	3.41280452E+04
58	4.63200640E+10	2.15220966E+05	3.42534805E+04
59	5.80671808E+10	2.40971328E+05	3.83517780E+04
60	5.99420189E+10	2.44830592E+05	3.89659990E+04
61	6.44205262E+10	2.53811990E+05	4.03954328E+04
62	7.36221531E+10	2.71334025E+05	4.31841513E+04
63	7.90525146E+10	2.81162790E+05	4.47484479E+04
64	8.89340148E+10	2.98218066E+05	4.74628793E+04
65	9.14049460E+10	3.02332509E+05	4.81177133E+04
66	1.04074143E+11	3.22605244E+05	5.13442192E+04
67	1.08622796E+11	3.29579726E+05	5.24542426E+04
68	1.13517921E+11	3.36924206E+05	5.36231529E+04
69	1.18761139E+11	3.44617381E+05	5.48475597E+04
70	1.30664888E+11	3.61475985E+05	5.75306899E+04
71	1.52514829E+11	3.90531469E+05	6.21550138E+04
72	1.80673634E+11	4.25057213E+05	6.76499566E+04
73	1.85042497E+11	4.30165662E+05	6.84629915E+04
74	2.09190996E+11	4.57374022E+05	7.27933365E+04
75	2.45235097E+11	4.95212174E+05	7.88154653E+04
76	2.80919183E+11	5.30018097E+05	8.43550000E+04
77	3.16380834E+11	5.62477407E+05	8.95210598E+04
78	3.39183434E+11	5.82394569E+05	9.26909745E+04
79	5.32994679E+11	7.30064846E+05	1.16193429E+05
80	7.31021133E+11	8.54997739E+05	1.36077116E+05

TABLE IX.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 2 - Continued

(c) Eigenvectors corresponding to the lowest five $n = 0$ natural frequencies for the ring-stiffened cone

VECTOR	W	U	V	BETA	U PRIME	V PRIME	BETA PRIME
1	0.	0.	0.	0.	0.	7.15620796E-01	0.
	0.	0.	7.25538707E-01	0.	0.	5.59359869E-01	0.
	0.	0.	1.86546380E+00	0.	0.	4.49015888E-01	0.
	0.	0.	2.84925027E+00	0.	0.	4.08987549E-01	0.
	0.	0.	3.76948629E+00	0.	0.	3.90043489E-01	0.
	0.	0.	4.65694908E+00	0.	0.	3.79208091E-01	0.
	0.	0.	5.52448438E+00	0.	0.	3.71473239E-01	0.
	0.	0.	6.37465147E+00	0.	0.	3.65937375E-01	0.
	0.	0.	7.21501177E+00	0.	0.	3.62091646E-01	0.
	0.	0.	8.04747053E+00	0.	0.	3.58917574E-01	0.
	0.	0.	8.87303968E+00	0.	0.	3.56077076E-01	0.
	0.	0.	9.69226958E+00	0.	0.	3.53408851E-01	0.
2	0.	0.	0.	0.	-2.67032863E-01	0.	1.45074135E+01
	6.28247508E-01	-2.92977856E-01	0.	1.02037275E-01	-2.12266018E-01	0.	5.76166896E+00
	1.88909070E+00	-7.23340925E-01	0.	3.74885831E-01	-1.54400647E-01	0.	-7.10587555E-01
	2.46547737E+00	-1.03339741E+00	0.	2.11515610E-01	-1.16308723E-01	0.	7.88764044E-02
	2.95556713E+00	-1.27296017E+00	0.	2.17467168E-01	-9.23644959E-02	0.	8.86054666E-02
	3.39080135E+00	-1.46682127E+00	0.	1.14234180E-01	-7.46626720E-02	0.	-5.37408404E-01
	3.92870707E+00	-1.63307214E+00	0.	-6.67713773E-01	-6.28646167E-02	0.	-5.49098231E-01
	4.16107872E+00	-1.75795233E+00	0.	1.40292661E-01	-5.25362006E-02	0.	4.56682823E-01
	4.58891485E+00	-1.86865066E+00	0.	2.03715456E-01	-4.47257767E-02	0.	-6.44892666E-02
	5.00783985E+00	-1.96521398E+00	0.	1.15535250E-01	-3.89507304E-02	0.	-9.20438996E-02
	5.71157810E+00	-2.04809860E+00	0.	1.36901031E+00	-3.36347452E-02	0.	2.20958532E+00
	1.12599553E+01	-2.16969828E+00	0.	-4.59692842E+00	-6.70640413E-02	0.	-2.18664663E+01
3	0.	0.	0.	0.	-2.98691058E-01	0.	1.63230678E+01
	7.09857808E-01	-3.28207779E-01	0.	1.12365450E-01	-2.36908040E-01	0.	6.56244001E+00
	2.17128005E+00	-8.08627429E-01	0.	4.46416215E-01	-1.72278957E-01	0.	-7.84093077E-01
	2.89789014E+00	-1.15402324E+00	0.	2.79328725E-01	-1.29166353E-01	0.	7.51980842E-02
	3.57921087E+00	-1.41937061E+00	0.	3.45972114E-01	-1.01346248E-01	0.	2.95488337E-01
	4.20496224E+00	-1.63092834E+00	0.	1.36805833E-01	-7.66998775E-02	0.	-1.18215745E+00
	7.03544178E+00	-1.83313938E+00	0.	-2.40247247E+00	-8.13285312E-02	0.	-7.86791910E+00
	5.57034782E+00	-1.93671574E+00	0.	3.51470073E-01	-4.26255042E-02	0.	1.73515436E+00
	6.82428904E+00	-2.02154061E+00	0.	6.26996273E-01	-3.46972786E-02	0.	-6.77321403E-02
	9.16230016E+00	-2.10010722E+00	0.	1.60804793E+00	-3.61167715E-02	0.	3.93027098E-01
	9.37251497E+00	-2.18406952E+00	0.	-4.61869300E+00	-2.51790419E-02	0.	-7.20550303E+00
	-7.99644235E+00	-2.07075601E+00	0.	6.59896675E+00	1.07110756E-01	0.	4.00864197E+01

4	0.	0.	0.	0.	-1.42525571E-01	0.	7.83762521E+00
	3.42335411E-01	-1.56862458E-01	0.	5.27274014E-02	-1.12774538E-01	0.	3.18978371E+00
	1.06651328E+00	-3.85636677E-01	0.	2.28627962E-01	-8.19811202E-02	0.	-3.61162858E-01
	1.46082541E+00	-5.49806018E-01	0.	1.55998950E-01	-6.10690638E-02	0.	3.13717132E-03
	1.87413034E+00	-6.75238771E-01	0.	2.71447015E-01	-4.67040590E-02	0.	4.74573923E-01
	2.15493725E+00	-7.71205303E-01	0.	1.15153997E-01	-2.54645636E-02	0.	-1.06196216E+00
	8.95596125E+00	-9.23320273E-01	0.	-4.60370321E+00	-7.90071699E-02	0.	-2.10426311E+01
	2.57742327E+00	-9.10774469E-01	0.	2.58511767E-01	1.60214501E-02	0.	3.80762410E+00
	5.27187464E+00	-8.78298481E-01	0.	1.27492021E+00	4.86325089E-03	0.	-1.38526118E+00
	-8.56493056E-01	-8.34587717E-01	0.	-8.76105735E+00	5.78095723E-02	0.	-5.34605109E+00
	-1.93949629E+01	-5.30272614E-01	0.	1.29925794E+00	1.71175502E-01	0.	1.39346721E+01
	9.27693712E-01	-3.59928181E-01	0.	1.68657331E-01	-1.81408884E-02	0.	-2.46831414E+01
5	0.	0.	0.	0.	-5.69212810E-02	0.	3.13812127E+00
	1.37255243E-01	-6.26856738E-02	0.	2.09309746E-02	-4.49927966E-02	0.	1.28110502E+00
	4.30360699E-01	-1.53983647E-01	0.	9.45838951E-02	-3.26765215E-02	0.	-1.35258080E-01
	5.95936934E-01	-2.19432442E-01	0.	6.26495150E-02	-2.41345291E-02	0.	-3.31390409E-02
	7.78567062E-01	-2.69216015E-01	0.	1.67818253E-01	-1.75317445E-02	0.	4.74986183E-01
	7.47198475E-01	-3.03548954E-01	0.	9.49597810E-02	6.89531694E-05	0.	-6.53737314E-01
	8.88733562E+00	-4.22545062E-01	0.	-5.10871088E+00	-7.46723598E-02	0.	-2.54970457E+01
	1.22449481E-01	-3.61123275E-01	0.	-2.83450816E-01	4.34554394E-02	0.	3.42650576E+00
	-5.05354243E+00	-2.30619797E-01	0.	-6.61537378E+00	8.13262954E-02	0.	-4.61634041E+00
	-1.86561654E+01	8.54630733E-02	0.	2.73320775E+00	1.58385829E-01	0.	1.35897576E+01
	9.69357951E+00	1.67561260E-01	0.	8.68445978E+00	-9.44838303E-02	0.	-1.61645199E+01
	-1.29501708E+00	5.68691654E-02	0.	3.20002308E-01	2.83298463E-02	0.	2.76080809E+01

TABLE IX.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 2 - Continued

(d) Natural frequencies for circumferential wave number n = 1 for the ring-stiffened cone

N = 1

FOR RING 1, RADIUS A = 3.46877100E+00

FOR RING 2, RADIUS A = 1.36763065E+01

FOR RING 3, RADIUS A = 2.36763590E+01

	EIGENVALUES	OMEGA	FREQUENCY
1	2.16984817E+05	4.65816291E+02	7.41369652E+01
2	1.16214043E+07	3.40901808E+03	5.42562079E+02
3	2.15907748E+07	4.64658744E+03	7.39527359E+02
4	2.55836489E+07	5.05802816E+03	8.05010184E+02
5	2.86140166E+07	5.34920710E+03	8.51352752E+02
6	3.08754369E+07	5.55656700E+03	8.84355105E+02
7	3.53522910E+07	5.94577926E+03	9.46300160E+02
8	4.20536700E+07	6.48488010E+03	1.03210072E+03
9	5.30220115E+07	7.28162149E+03	1.15890605E+03
10	5.92605977E+07	7.69809053E+03	1.22518916E+03
11	7.18458244E+07	8.47619162E+03	1.34902779E+03
12	7.90054110E+07	8.88849880E+03	1.41464852E+03
13	9.65253026E+07	9.82472914E+03	1.56365421E+03
14	1.00019669E+08	1.00009834E+04	1.59170594E+03
15	1.08852339E+08	1.04332324E+04	1.66050052E+03
16	1.20984834E+08	1.09993106E+04	1.75059465E+03
17	1.42440577E+08	1.19348472E+04	1.89948992E+03
18	1.48781223E+08	1.21975909E+04	1.94130688E+03
19	1.77650279E+08	1.33285513E+04	2.12130482E+03
20	1.94469415E+08	1.39452291E+04	2.21945215E+03
21	2.01029860E+08	1.41784999E+04	2.25657835E+03
22	2.15742345E+08	1.46881702E+04	2.33769490E+03
23	2.54751719E+08	1.59609436E+04	2.54026306E+03
24	2.74340340E+08	1.65632225E+04	2.63611874E+03
25	2.98870481E+08	1.72878709E+04	2.75145011E+03
26	3.31289045E+08	1.82013474E+04	2.89683440E+03
27	3.61803608E+08	1.90211358E+04	3.02730779E+03
28	4.05453906E+08	2.01358860E+04	3.20472579E+03
29	4.54580912E+08	2.13209032E+04	3.39332713E+03
30	5.09903129E+08	2.25810347E+04	3.59388329E+03
31	5.75385447E+08	2.39871934E+04	3.81768040E+03
32	6.85757653E+08	2.61869749E+04	4.16778650E+03
33	7.31108318E+08	2.70390147E+04	4.30339285E+03
34	7.94587325E+08	2.81884254E+04	4.48632724E+03
35	9.48506357E+08	3.07978304E+04	4.90162694E+03
36	1.15186780E+09	3.39391779E+04	5.40158793E+03
37	1.83280885E+09	4.28113168E+04	6.81363269E+03
38	2.13049854E+09	4.61573238E+04	7.34616625E+03
39	2.76103848E+09	5.25455848E+04	8.36288956E+03
40	3.57068398E+09	5.97552004E+04	9.51033552E+03
41	5.32946584E+09	7.30031906E+04	1.16188186E+04
42	6.02473861E+09	7.76191897E+04	1.23534777E+04
43	6.53683070E+09	8.08506691E+04	1.28677836E+04
44	7.71079545E+09	8.78111351E+04	1.39755762E+04
45	9.97025158E+09	9.98511471E+04	1.58918036E+04
46	1.09776555E+10	1.04774307E+05	1.66753489E+04
47	1.23789230E+10	1.11260608E+05	1.77076758E+04
48	1.43782327E+10	1.19909269E+05	1.90841528E+04
49	1.84243273E+10	1.35736242E+05	2.16030938E+04
50	1.97442806E+10	1.40514343E+05	2.23635523E+04
51	2.12961113E+10	1.45931872E+05	2.32257788E+04
52	2.62634596E+10	1.62060049E+05	2.57926579E+04
53	2.93992031E+10	1.71461958E+05	2.72890182E+04
54	3.21914659E+10	1.79419803E+05	2.85555486E+04

55	3.63546781E+10	1.90669028E+05	3.03459182E+04
56	4.19833045E+10	2.04898278E+05	3.26105738E+04
57	4.58811625E+10	2.14198885E+05	3.40908114E+04
58	4.72162200E+10	2.17292936E+05	3.45832448E+04
59	5.80543033E+10	2.40944606E+05	3.83475251E+04
60	6.03906877E+10	2.45745168E+05	3.91115583E+04
61	6.49282760E+10	2.54810274E+05	4.05543147E+04
62	7.39448386E+10	2.71928003E+05	4.32786858E+04
63	7.93344669E+10	2.81663748E+05	4.48281778E+04
64	8.89304709E+10	2.98212124E+05	4.74619336E+04
65	9.23289761E+10	3.03856835E+05	4.83603173E+04
66	1.04542755E+11	3.23330721E+05	5.14596825E+04
67	1.09021469E+11	3.30183992E+05	5.25504145E+04
68	1.14431166E+11	3.38276760E+05	5.38384185E+04
69	1.19057552E+11	3.45047174E+05	5.49159633E+04
70	1.31281666E+11	3.62328120E+05	5.76663113E+04
71	1.52894695E+11	3.91017512E+05	6.22323699E+04
72	1.81128722E+11	4.25592202E+05	6.77351026E+04
73	1.88077355E+11	4.33678861E+05	6.90221345E+04
74	2.09543044E+11	4.57758718E+05	7.28545627E+04
75	2.45562390E+11	4.95643410E+05	7.88840987E+04
76	2.81313119E+11	5.30389592E+05	8.44141253E+04
77	3.16935479E+11	5.62970230E+05	8.95994948E+04
78	3.39689005E+11	5.82828453E+05	9.27600292E+04
79	5.34359305E+11	7.30998840E+05	1.16342079E+05
80	7.31055450E+11	8.55017807E+05	1.36080310E+05

TABLE IX.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 2 - Continued

(e) Eigenvectors corresponding to the lowest five n = 1 natural frequencies for the ring-stiffened cone

VECTOR	W	U	V	BETA	U PRIME	V PRIME	BETA PRIME
1	0.	0.	0.	0.	-1.06802334E-01	-3.03445992E-01	8.18428619E+00
	9.06677196E-01	-1.05981647E-01	-3.38947905E-01	2.46060561E-01	-6.43198864E-02	-2.75346966E-01	2.68953932E+00
	2.37771401E+00	-2.12714021E-01	-9.45043338E-01	5.54393149E-01	-3.09878996E-02	-2.51803956E-01	-1.11620806E-01
	3.57650282E+00	-2.65555627E-01	-1.51386234E+00	5.02350623E-01	-1.67723817E-02	-2.41943591E-01	1.50083467E-03
	4.71914809E+00	-2.95892091E-01	-2.06636362E+00	4.89285892E-01	-1.02515011E-02	-2.36967786E-01	2.43087488E-03
	5.83421565E+00	-3.15213618E-01	-2.60998876E+00	4.72837997E-01	-6.70126531E-03	-2.33924507E-01	-5.03246182E-02
	6.92932716E+00	-3.28651537E-01	-3.14776378E+00	4.08822824E-01	-4.57452656E-03	-2.31303941E-01	1.46088333E-02
	8.01885643E+00	-3.37424800E-01	-3.67954109E+00	4.65467774E-01	-3.48863966E-03	-2.29620716E-01	3.45273313E-02
	9.10100374E+00	-3.44316722E-01	-4.20822308E+00	4.69090426E-01	-2.62142287E-03	-2.28318579E-01	-5.97918315E-03
	1.01810503E+01	-3.49706258E-01	-4.73418912E+00	4.66128261E-01	-2.08563533E-03	-2.27197419E-01	-2.03826262E-03
	1.12604750E+01	-3.54032798E-01	-5.25768472E+00	4.86942527E-01	-1.67059042E-03	-2.26166356E-01	4.98959714E-02
	1.24461012E+01	-3.58689821E-01	-5.77859361E+00	3.14405052E-01	-2.29191245E-03	-2.24818082E-01	-6.52598212E-01
2	0.	0.	0.	0.	3.21292396E-02	-5.34804253E-01	2.46265196E+00
	9.60232250E-01	5.35651806E-02	-5.33553404E-01	1.95830057E-01	6.10442199E-02	-3.95722376E-01	1.05912948E-01
	2.02116920E+00	2.15373720E-01	-1.29496163E+00	4.01877222E-01	6.95726857E-02	-2.78224976E-01	3.33136317E-01
	2.97088633E+00	3.69658940E-01	-1.86160325E+00	3.89840008E-01	6.25003210E-02	-2.17464942E-01	-9.38174700E-02
	3.82537023E+00	5.03922474E-01	-2.31460583E+00	3.85645664E-01	5.40972234E-02	-1.76035840E-01	1.38179362E-01
	4.59642641E+00	6.19516138E-01	-2.68344249E+00	2.59541279E-01	4.94312738E-02	-1.40163636E-01	-4.30760092E-01
	7.37143307E+00	6.97546224E-01	-2.97208925E+00	-9.64381032E-01	2.30870460E-02	-8.24237632E-02	-7.59678252E+00
	5.89599586E+00	7.98330732E-01	-3.08827481E+00	2.10404827E-01	4.17106379E-02	-3.98834203E-02	1.07690147E+00
	6.64127270E+00	8.87808372E-01	-3.14661911E+00	3.16064798E-01	3.41446121E-02	-1.37010783E-02	-8.79290230E-02
	7.84408905E+00	9.57049379E-01	-3.14891246E+00	9.63690173E-01	2.40981664E-02	1.13742012E-02	3.91880098E-01
	6.79407200E+00	1.00119452E+00	-3.08656379E+00	-5.60465380E+00	2.35607242E-02	4.13744482E-02	-8.82457624E+00
	-1.52629000E+01	1.25081829E+00	-3.01679233E+00	1.10191129E+01	1.75141568E-01	-3.85144891E-03	6.16672797E+01
3	0.	0.	0.	0.	3.98487039E-02	-5.09075049E-01	1.90380589E+00
	8.99072982E-01	6.07461365E-02	-5.05846875E-01	1.76997491E-01	6.56908812E-02	-3.70008480E-01	-8.10739442E-02
	1.86987330E+00	2.29110705E-01	-1.20550183E+00	3.77282730E-01	7.07337451E-02	-2.50706823E-01	3.55469058E-01
	2.78416739E+00	3.83668609E-01	-1.70312733E+00	3.79822145E-01	6.19022092E-02	-1.84504788E-01	-1.21450677E-01
	3.65614504E+00	5.14415011E-01	-2.07181402E+00	4.62639036E-01	5.28656615E-02	-1.33872114E-01	4.63501460E-01
	4.30798699E+00	6.26581116E-01	-2.33448468E+00	2.75734786E-01	5.66497001E-02	-8.22468478E-02	-7.30129690E-01
	1.33307600E+01	6.29452111E-01	-2.46311624E+00	-4.57759817E+00	-3.25184458E-02	6.03983427E-02	-2.83891506E+01
	3.86080920E+00	7.77075795E-01	-2.14163493E+00	-5.75443890E-01	7.55366623E-02	1.47602498E-01	4.06114573E+00
	3.60149797E+00	9.41803254E-01	-1.76031695E+00	-8.00094006E-01	6.27862818E-02	1.72783471E-01	-2.16483570E+00
	-7.96289727E+00	1.13493466E+00	-1.35249270E+00	-1.05244153E+01	1.26570108E-01	1.67813165E-01	-3.95022832E+00
	-2.53082362E+01	1.56552127E+00	-1.08422421E+00	4.50333452E+00	2.02486386E-01	5.02705912E-02	1.62763227E+01
	3.05012791E+00	1.72294127E+00	-1.05545407E+00	-1.05595932E+00	-4.95694735E-02	5.18533655E-03	-3.58126081E+01

4	0.	0.	0.	0.	-1.05316142E-02	-1.14066519E-01	1.51945644E+00
	2.62281800E-01	-7.78009727E-03	-1.19191481E-01	6.08695291E-02	-5.28088709E-04	-8.97774613E-02	4.16773999E-01
	6.32999059E-01	-1.07183709E-03	-2.98336012E-01	1.47779970E-01	4.65161092E-03	-6.77652265E-02	4.62499136E-02
	9.79577765E-01	1.07123932E-02	-4.37981673E-01	1.47121538E-01	5.32475564E-03	-5.33195838E-02	-5.09242590E-02
	1.35378525E+00	2.15635524E-02	-5.47018731E-01	2.46154314E-01	5.53282577E-03	-3.88787436E-02	4.25475085E-01
	1.50739658E+00	3.45303613E-02	-6.25145979E-01	2.01572436E-01	1.77123946E-02	-1.85759852E-02	-2.72985422E-01
	1.05547813E+01	-5.19728559E-02	-6.32587860E-01	-4.76169891E+00	-6.99612380E-02	9.42896700E-02	-2.87160270E+01
	-5.64447832E-01	3.16735536E-02	-2.73966489E-01	-1.52834634E+00	5.78706739E-02	1.50991658E-01	2.85205370E+00
	-1.06526663E+01	2.15005927E-01	6.32025111E-02	-9.43312416E+00	1.16615780E-01	1.22315928E-01	-4.25999178E+00
	-2.40135190E+01	6.12443548E-01	1.90179259E-01	7.93328957E+00	1.72249554E-01	-2.61036895E-02	1.85391967E+01
	1.88159627E+01	5.89733135E-01	6.17191661E-02	1.00416729E+01	-1.82075970E-01	-3.88530294E-02	-2.47625101E+01
	-1.63672552E+00	3.80607950E-01	7.97809324E-02	-2.18336622E-01	3.41001572E-02	2.82292730E-02	4.02457910E+01
5	0.	0.	0.	0.	3.40641143E-01	-1.07788539E+00	-1.01943637E+01
	1.13484776E+00	4.09392794E-01	-9.95855460E-01	9.70706313E-02	3.40564715E-01	-6.84948656E-01	-5.89389558E+00
	1.23358000E+00	1.17337151E+00	-2.14968975E+00	2.03428432E-02	2.95532316E-01	-3.58755532E-01	1.28423516E+00
	1.45960737E+00	1.79437790E+00	-2.77045722E+00	4.14972687E-02	2.40916232E-01	-1.95043005E-01	-2.13479291E-01
	1.26889974E+00	2.30176915E+00	-3.09472176E+00	-2.83190066E-01	1.97070244E-01	-9.58339966E-02	-7.62998514E-01
	1.15197701E+00	2.71546022E+00	-3.22635245E+00	-5.24637191E-01	1.41955486E-01	-3.38803157E-02	2.14080735E-01
	-1.39591577E+01	3.23327087E+00	-3.28924781E+00	8.54435992E+00	2.58843282E-01	-1.33945432E-01	4.56970822E+01
	6.65334852E+00	3.37503643E+00	-3.71266212E+00	4.48803470E+00	1.21536340E-03	-1.47874031E-01	-5.28924445E+00
	1.15843208E+01	3.30320732E+00	-3.94054187E+00	-4.10089279E+00	-2.99427959E-02	-3.60330844E-02	-9.27963179E+00
	-1.65171404E+01	3.48794397E+00	-3.96887176E+00	-9.81382634E+00	2.00274230E-01	-2.27786274E-02	1.45974572E+01
	2.47822888E+00	3.78643026E+00	-4.12321343E+00	1.40649296E+01	-1.10191216E-02	-8.63700349E-02	-1.28613428E+01
	-8.92784220E-02	3.76747218E+00	-4.26064779E+00	3.78605544E+00	4.41753734E-02	-4.20084498E-02	3.61902025E+01

TABLE IX.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 2 - Continued

(f) Natural frequencies for circumferential wave number n = 2 for the ring-stiffened cone

N = 2

FOR RING 1, RADIUS A = 3.46877100E+00

FOR RING 2, RADIUS A = 1.36763065E+01

FOR RING 3, RADIUS A = 2.36763590E+01

	EIGENVALUES	OMEGA	FREQUENCY
1	6.37051699E+04	2.52398831E+02	4.01705216E+01
2	7.07307791E+06	2.65952588E+03	4.23276690E+02
3	1.61383910E+07	4.01726163E+03	6.39367046E+02
4	2.40750517E+07	4.90663344E+03	7.80914966E+02
5	2.86210886E+07	5.34986809E+03	8.51457952E+02
6	3.19276446E+07	5.65045525E+03	8.99297885E+02
7	3.46718349E+07	5.88827945E+03	9.37148781E+02
8	4.16660877E+07	6.45492740E+03	1.02733360E+03
9	5.29876735E+07	7.27926325E+03	1.15853073E+03
10	6.34217102E+07	7.96377487E+03	1.26747414E+03
11	6.67632182E+07	8.17087622E+03	1.30043534E+03
12	7.18630918E+07	8.47721014E+03	1.34918990E+03
13	8.34363852E+07	9.13435193E+03	1.45377726E+03
14	9.97333138E+07	9.98665679E+03	1.58942579E+03
15	1.03786705E+08	1.01875760E+04	1.62140308E+03
16	1.25087916E+08	1.11842709E+04	1.78003200E+03
17	1.33300515E+08	1.15455842E+04	1.83753680E+03
18	1.46217654E+08	1.20920492E+04	1.92450940E+03
19	1.59613325E+08	1.26338167E+04	2.01073438E+03
20	1.81183177E+08	1.34604300E+04	2.14229398E+03
21	1.98860378E+08	1.41017863E+04	2.24436900E+03
22	2.20410696E+08	1.48462351E+04	2.36285170E+03
23	2.57408963E+08	1.60439697E+04	2.55347708E+03
24	2.85139223E+08	1.68860659E+04	2.68750086E+03
25	3.14320348E+08	1.77290820E+04	2.82167104E+03
26	3.37981370E+08	1.83842696E+04	2.92594739E+03
27	3.76912386E+08	1.94142315E+04	3.08987092E+03
28	4.17757459E+08	2.04391159E+04	3.25298633E+03
29	4.38713063E+08	2.09454783E+04	3.33357641E+03
30	5.05973504E+08	2.24938548E+04	3.58000818E+03
31	5.71064963E+08	2.38969656E+04	3.80332019E+03
32	6.85615611E+08	2.61842627E+04	4.16735483E+03
33	7.31393716E+08	2.70442917E+04	4.30423271E+03
34	9.57496367E+08	3.09434382E+04	4.92480114E+03
35	1.25815060E+09	3.54704186E+04	5.64529246E+03
36	1.58206602E+09	3.97751935E+04	6.33041865E+03
37	1.79750434E+09	4.23969850E+04	6.74768974E+03
38	2.50859245E+09	5.00858508E+04	7.97141073E+03
39	3.86633532E+09	6.21798626E+04	9.89623250E+03
40	4.48122776E+09	6.69419731E+04	1.06541459E+04
41	5.71455911E+09	7.55947029E+04	1.20312706E+04
42	7.03276363E+09	8.38615742E+04	1.33469841E+04
43	8.27501392E+09	9.09671035E+04	1.44778642E+04
44	8.77770332E+09	9.36893981E+04	1.49111308E+04
45	1.10212725E+10	1.04982248E+05	1.67084438E+04
46	1.24361997E+10	1.11517710E+05	1.77485948E+04
47	1.29227293E+10	1.13678183E+05	1.80924448E+04
48	1.83487930E+10	1.35457717E+05	2.15587652E+04
49	1.87162853E+10	1.36807475E+05	2.17735860E+04
50	2.04756301E+10	1.43093082E+05	2.27739713E+04
51	2.42852814E+10	1.55837356E+05	2.48022855E+04
52	2.72719417E+10	1.65142186E+05	2.62831953E+04
53	3.02301300E+10	1.73868140E+05	2.76719739E+04
54	3.32832723E+10	1.82437036E+05	2.90357561E+04

55	3.77714458E+10	1.94348773E+05	3.09315680E+04
56	4.24182417E+10	2.05956893E+05	3.27790576E+04
57	4.63063626E+10	2.15189132E+05	3.42484141E+04
58	4.92632532E+10	2.21953268E+05	3.53249598E+04
59	5.83289878E+10	2.41513949E+05	3.84381389E+04
60	6.13397423E+10	2.47668614E+05	3.94176841E+04
61	6.65333191E+10	2.57940534E+05	4.10525110E+04
62	7.49342872E+10	2.73741278E+05	4.35672775E+04
63	8.01944773E+10	2.83186294E+05	4.50704986E+04
64	8.93387242E+10	2.98895842E+05	4.75707507E+04
65	9.45628955E+10	3.07510806E+05	4.89418648E+04
66	1.05756296E+11	3.25201931E+05	5.17574948E+04
67	1.10188865E+11	3.31947082E+05	5.28310189E+04
68	1.16818595E+11	3.41787354E+05	5.43971468E+04
69	1.20512961E+11	3.47149767E+05	5.52506015E+04
70	1.33294078E+11	3.65094616E+05	5.81066128E+04
71	1.54096881E+11	3.92551756E+05	6.24765524E+04
72	1.82533617E+11	4.27239531E+05	6.79972833E+04
73	1.97024148E+11	4.43874023E+05	7.06447449E+04
74	2.10671353E+11	4.58989492E+05	7.30504464E+04
75	2.46973746E+11	4.96964531E+05	7.90943617E+04
76	2.82504558E+11	5.31511578E+05	8.45926949E+04
77	3.18580329E+11	5.64429206E+05	8.98316982E+04
78	3.41353186E+11	5.84254385E+05	9.29869734E+04
79	5.38499099E+11	7.33824979E+05	1.16791873E+05
80	7.31158644E+11	8.55078151E+05	1.36089914E+05

TABLE IX.- PRINTOUT OF RESULTS OF SAMPLE CALCULATION 2 - Concluded

(g) Eigenvectors corresponding to the lowest five n = 2 frequencies for the ring-stiffened cone

VECTOR	W	U	V	BETA	U PRIME	V PRIME	BETA PRIME
1	0.	0.	0.	0.	-6.63041937E-02	-8.14044927E-02	5.15395303E+00
	7.22796847E-01	-6.65677144E-02	-1.18127163E-01	3.98407375E-01	-4.49341809E-02	-1.13120648E-01	1.79786342E-01
	1.91660310E+00	-1.34653548E-01	-4.03172199E-01	5.25926694E-01	-1.93088438E-02	-1.28266958E-01	8.12090866E-02
	3.16255859E+00	-1.66938894E-01	-7.05425463E-01	5.46751269E-01	-1.02243611E-02	-1.32400550E-01	1.36716530E-02
	4.41696290E+00	-1.85205668E-01	-1.01317240E+00	5.15025150E-01	-6.44382101E-03	-1.33970066E-01	-1.94153141E-01
	5.66279005E+00	-1.97155955E-01	-1.32298536E+00	6.71414236E-01	-6.14432712E-03	-1.34865659E-01	1.03723510E+00
	7.17378294E+00	-2.01526684E-01	-1.63798523E+00	1.87809212E+00	-7.17922036E-03	-1.43916048E-01	-1.06923231E+00
	8.22628053E+00	-2.14806904E-01	-1.96006943E+00	6.39744157E-01	1.27603506E-04	-1.37071239E-01	-7.04969949E-01
	9.51573979E+00	-2.17541833E-01	-2.27695156E+00	5.33563319E-01	-9.80231859E-04	-1.37052078E-01	1.14349537E-01
	1.07910348E+01	-2.19805881E-01	-2.59294720E+00	5.55709837E-01	-8.38468498E-04	-1.36584007E-01	-1.95326206E-02
	1.20088558E+01	-2.21417819E-01	-2.90774405E+00	4.57594267E-01	-5.68931501E-04	-1.36031363E-01	-6.33807178E-02
	1.38611412E+01	-2.22199501E-01	-3.22262542E+00	2.04662109E+00	-3.21677518E-03	-1.36300128E-01	2.13310478E+00
2	0.	0.	0.	0.	-3.59733754E-02	-8.51546319E-01	1.71713091E+01
	4.24769711E+00	1.68144064E-02	-8.60955234E-01	1.96322209E+00	4.94392790E-02	-6.77265464E-01	-9.20499180E+00
	7.46178623E+00	3.13797259E-01	-2.11138874E+00	1.13057038E+00	1.49994984E-01	-4.07738314E-01	1.50570280E+00
	9.85094290E+00	6.66714816E-01	-2.83444794E+00	7.81169952E-01	1.46568580E-01	-2.26127337E-01	-4.79271425E-01
	1.10032454E+01	9.85024888E-01	-3.19881650E+00	2.33465858E-01	1.26988764E-01	-9.41205107E-02	-5.19272673E-01
	1.11652833E+01	1.25540237E+00	-3.29706224E+00	1.29433341E-01	1.04573951E-01	1.15914295E-02	2.13272438E+00
	1.35578169E+01	1.47030143E+00	-3.18588517E+00	2.02434620E+00	5.66109464E-02	1.22207762E-01	-1.21261607E+01
	8.55686171E+00	1.63891186E+00	-2.71240084E+00	-9.60796893E-01	7.99784643E-02	2.33464781E-01	-6.91547838E-01
	5.99789047E+00	1.79320418E+00	-2.12194890E+00	-1.30410260E+00	5.68220854E-02	2.69508702E-01	3.53010771E-02
	2.81878139E+00	1.90763213E+00	-1.47600570E+00	-1.39893584E+00	4.30560082E-02	2.85974964E-01	7.13554806E-03
	-1.24090030E+00	1.99496630E+00	-8.09700066E-01	-3.16755873E+00	3.45290775E-02	2.87785694E-01	-2.74129187E+00
	-1.19267916E+01	2.12986679E+00	-1.89544255E-01	3.00765572E+00	7.92191556E-02	2.32516418E-01	2.45424763E+01
3	0.	0.	0.	0.	-1.54431303E-02	-5.63011648E-01	1.12023310E+01
	2.81460394E+00	2.03394950E-02	-5.66847008E-01	1.29030057E+00	3.90704162E-02	-4.28205267E-01	-6.50032598E+00
	4.74027356E+00	2.22496660E-01	-1.31832359E+00	6.57036580E-01	9.75749206E-02	-2.29035598E-01	1.00642600E+00
	6.06672013E+00	4.45145311E-01	-1.67884217E+00	3.80166853E-01	8.93714115E-02	-8.85649441E-02	-3.55401721E-01
	6.43292182E+00	6.32173754E-01	-1.75624694E+00	-4.24615092E-02	7.16264256E-02	1.91216621E-02	-2.92206540E-01
	5.85507261E+00	7.78207570E-01	-1.61615852E+00	-3.08618692E-01	5.57650374E-02	1.08723534E-01	1.18693025E+00
	8.25523902E+00	8.63716553E-01	-1.29669559E+00	-8.92782039E-02	4.18970811E-03	2.33617377E-01	-1.45357249E+01
	1.30665939E-01	9.47085301E-01	-5.67880187E-01	-2.29230617E+00	4.71794264E-02	3.21170422E-01	3.27154318E-01
	-5.52658333E+00	1.04629036E+00	1.57160717E-01	-2.95800499E+00	4.14385320E-02	2.90288933E-01	-6.66532679E-01
	-1.51038380E+01	1.16520829E+00	7.32268978E-01	-5.54207252E+00	6.81739818E-02	1.93872648E-01	-6.67421082E-01
	-2.03947805E+01	1.35941500E+00	9.73442249E-01	6.85636932E+00	7.63107564E-02	1.07129125E-02	1.31766647E+01
	9.65953992E+00	1.25507347E+00	9.47547989E-01	-6.98175275E+00	-1.47262694E-01	2.97644172E-02	-5.83011798E+01

4	0.	0.	0.	0.	-1.48727299E-02	-1.69381333E-01	4.05377015E+00
	9.14823768E-01	-4.92845322E-03	-1.77155636E-01	4.29449360E-01	3.62429788E-03	-1.32157741E-01	-1.86294277E+00
	1.61740804E+00	3.76587102E-02	-4.11255225E-01	2.58203256E-01	2.16572653E-02	-7.28124980E-02	2.95977187E-01
	2.15688186E+00	8.64609743E-02	-5.24195660E-01	1.74413608E-01	1.87198034E-02	-2.58351743E-02	-1.06684252E-01
	2.39533671E+00	1.22489533E-01	-5.37799831E-01	4.04589070E-02	1.23680872E-02	1.52264509E-02	-7.25310078E-02
	2.16590967E+00	1.44659350E-01	-4.66694953E-01	-5.24992649E-02	9.85325095E-03	5.58706854E-02	8.50237711E-01
	6.04476610E+00	1.15397770E-01	-3.00966912E-01	-1.05010729E+00	-4.03196507E-02	1.66308265E-01	-1.60501086E+01
	-3.55319528E+00	1.36369364E-01	2.42035181E-01	-3.31855648E+00	3.08103761E-02	2.19804891E-01	3.19802948E-02
	-1.58378934E+01	2.60007769E-01	6.42936688E-01	-7.62716964E+00	8.76354396E-02	9.46666098E-02	-2.69600755E-01
	-1.79729896E+01	5.07291035E-01	5.40704882E-01	1.28212777E+01	7.25621333E-02	-1.84043944E-01	1.50364542E+01
	2.39601563E+01	3.00812713E-01	1.04743927E-01	5.87735853E+00	-2.19138364E-01	-1.09264098E-01	-2.49777304E+01
	-1.91056140E+00	7.25657036E-02	8.99979026E-02	-3.62953658E-01	3.79993882E-02	3.48637657E-02	4.18644869E+01
5	0.	0.	0.	0.	4.54494838E-03	-2.29071678E-02	1.71861600E-01
	8.95354442E-02	6.45021201E-03	-2.01733658E-02	3.55849667E-02	5.65897673E-03	-1.31748691E-02	-3.66560751E-01
	8.78330562E-02	2.25612059E-02	-3.63533713E-02	-1.17728014E-02	6.71046491E-03	-1.96897667E-03	4.30889992E-02
	4.42144084E-02	3.71911932E-02	-3.27071128E-02	-3.14101929E-02	5.74702753E-03	3.90092847E-03	-2.29466328E-02
	-6.92851466E-02	4.97262743E-02	-1.88324559E-02	-7.33647680E-02	4.66896271E-03	4.38121917E-03	-5.24424039E-02
	5.96399582E-03	5.76938099E-02	-2.82242859E-03	-2.58295067E-01	-3.15503786E-03	-5.72124553E-03	-1.34198293E+00
	-7.35403923E+00	1.36234912E-01	-4.23998572E-02	1.99663914E+00	7.30058625E-02	-1.49490266E-01	2.49628117E+01
	1.06949858E+01	8.52245536E-02	-5.85291434E-01	8.43335177E+00	-8.17591010E-02	-1.89285290E-01	8.18097574E-02
	2.25482823E+01	-2.12415425E-01	-7.09447662E-01	-5.99578233E+00	-1.34963662E-01	1.19247404E-01	-1.66691293E+01
	-2.11519411E+01	-1.24052465E-01	-2.85251954E-01	-1.44821060E+01	2.23304864E-01	1.40182963E-01	2.36252299E+01
	8.33966283E+00	1.48535330E-01	-2.82650913E-01	1.97084794E+01	-8.20328218E-02	-6.21377201E-02	-2.18341358E+01
	-2.39611305E+00	3.74675806E-02	-2.76788662E-01	9.83764505E-01	5.92164212E-02	2.86389448E-02	4.89409815E+01

TABLE X.- ELEMENTS OF MATRIX $[A_k]$

$$
\begin{bmatrix}
1 & -\frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & -\frac{\epsilon_k^3}{8} & \frac{\epsilon_k^4}{16} & -\frac{\epsilon_k^5}{32} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & -\frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & -\frac{\epsilon_k^3}{8} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -\frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & -\frac{\epsilon_k^3}{8} \\
0 & 1 & \epsilon_k & \frac{3\epsilon_k^2}{4} & \frac{\epsilon_k^3}{2} & \frac{5\epsilon_k^4}{16} & -\frac{1}{R_{1,k}} & -\frac{\epsilon_k}{2R_{1,k}} & -\frac{\epsilon_k^2}{4R_{1,k}} & \frac{\epsilon_k^3}{8R_{1,k}} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -\epsilon_k & \frac{3\epsilon_k^3}{4} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -\epsilon_k & \frac{3\epsilon_k^2}{4} \\
0 & 0 & 2 & -3\epsilon_k & 3\epsilon_k^2 & -\frac{5\epsilon_k^3}{2} & \frac{R'_{1,k}}{R_{1,k}^2} & -\frac{1}{R_{1,k}}\left(\frac{\epsilon_k R'_{1,k}}{2R_{1,k}} + 1\right) & \frac{\epsilon_k}{R_{1,k}}\left(\frac{\epsilon_k R'_{1,k}}{4R_{1,k}} + 1\right) & -\frac{\epsilon_k^2}{4R_{1,k}}\left(\frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}} + 3\right) & 0 & 0 & 0 & 0 \\
1 & \frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & \frac{\epsilon_k^3}{8} & \frac{\epsilon_k^4}{16} & \frac{\epsilon_k^5}{32} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & \frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & \frac{\epsilon_k^3}{8} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & \frac{\epsilon_k}{2} & \frac{\epsilon_k^2}{4} & \frac{\epsilon_k^3}{8} \\
0 & 1 & \epsilon_k & \frac{3\epsilon_k^3}{4} & \frac{\epsilon_k^3}{2} & \frac{5\epsilon_k^4}{16} & -\frac{1}{R_{1,k+1}} & -\frac{\epsilon_k}{2R_{1,k+1}} & -\frac{\epsilon_k^2}{4R_{1,k+1}} & -\frac{\epsilon_k^3}{8R_{1,k+1}} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & \epsilon_k & \frac{3\epsilon_k^2}{4} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & \epsilon_k & \frac{3\epsilon_k^2}{4} \\
0 & 0 & 2 & 3\epsilon_k & 3\epsilon_k^2 & \frac{5\epsilon_k^2}{2} & \frac{R'_{1,k+1}}{R_{1,k+1}^2} & \frac{1}{R_{1,k+1}}\left(\frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}} - 1\right) & \frac{\epsilon_k}{R_{1,k+1}}\left(\frac{\epsilon_k R'_{1,k+1}}{4R_{1,k+1}} - 1\right) & \frac{\epsilon_k^2}{4R_{1,k+1}}\left(\frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}} - 3\right) & 0 & 0 & 0 & 0
\end{bmatrix}
$$

TABLE XI.- ELEMENTS OF MATRIX $[T_k]$

$$
\begin{bmatrix}
\frac{1}{2} & \frac{\epsilon_k}{32R_{1,k}}\left(5-\frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & \frac{5\epsilon_k}{32} & \frac{\epsilon_k^2}{64R_{1,k}} & 0 & \frac{\epsilon_k^2}{64} & \frac{1}{2} & -\frac{\epsilon_k}{32R_{1,k+1}}\left(5+\frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & -\frac{5\epsilon_k}{32} & \frac{\epsilon_k^2}{64R_{1,k+1}} & 0 & \frac{\epsilon_k^2}{64} \\
-\frac{15}{8\epsilon_k} & \frac{1}{16R_{1,k}}\left(-7+\frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & -\frac{7}{16} & -\frac{\epsilon_k}{32R_{1,k}} & 0 & -\frac{\epsilon_k}{32} & \frac{15}{8\epsilon_k} & -\frac{1}{16R_{1,k+1}}\left(7+\frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & -\frac{7}{16} & \frac{\epsilon_k}{32R_{1,k+1}} & 0 & \frac{\epsilon_k}{32} \\
0 & \frac{1}{4\epsilon_k R_{1,k}}\left(-3+\frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & -\frac{3}{4\epsilon_k} & -\frac{1}{8R_{1,k}} & 0 & -\frac{1}{8} & 0 & \frac{1}{4\epsilon_k R_{1,k+1}}\left(3+\frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & \frac{3}{4\epsilon_k} & -\frac{1}{8R_{1,k+1}} & 0 & -\frac{1}{8} \\
\frac{5}{\epsilon_k^3} & \frac{1}{2\epsilon_k^2 R_{1,k}}\left(5-\frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & \frac{5}{2\epsilon_k^2} & \frac{1}{4\epsilon_k R_{1,k}} & 0 & \frac{1}{4\epsilon_k} & -\frac{5}{\epsilon_k^3} & \frac{1}{2\epsilon_k^2 R_{1,k+1}}\left(5+\frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & \frac{5}{2\epsilon_k^2} & -\frac{1}{4\epsilon_k R_{1,k+1}} & 0 & -\frac{1}{4\epsilon_k} \\
0 & \frac{1}{2\epsilon_k^3 R_{1,k}}\left(1-\frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & \frac{1}{2\epsilon_k^3} & \frac{1}{4\epsilon_k^2 R_{1,k}} & 0 & \frac{1}{4\epsilon_k^2} & 0 & -\frac{1}{2\epsilon_k^3 R_{1,k+1}}\left(1+\frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & -\frac{1}{2\epsilon_k^3} & \frac{1}{4\epsilon_k^2 R_{1,k+1}} & 0 & \frac{1}{4\epsilon_k^2} \\
-\frac{6}{\epsilon_k^5} & \frac{1}{\epsilon_k^4 R_{1,k}}\left(-1+\frac{\epsilon_k R'_{1,k}}{2R_{1,k}}\right) & 0 & -\frac{3}{\epsilon_k^4} & -\frac{1}{2\epsilon_k^3 R_{1,k}} & 0 & -\frac{1}{2\epsilon_k^3} & \frac{6}{\epsilon_k^5} & -\frac{1}{\epsilon_k^4 R_{1,k+1}}\left(3+\frac{\epsilon_k R'_{1,k+1}}{2R_{1,k+1}}\right) & 0 & -\frac{3}{\epsilon_k^4} & \frac{1}{2\epsilon_k^3 R_{1,k+1}} & 0 & \frac{1}{2\epsilon_k^3} \\
0 & \frac{1}{2} & 0 & 0 & \frac{\epsilon_k}{8} & 0 & 0 & 0 & \frac{1}{2} & 0 & 0 & -\frac{\epsilon_k}{8} & 0 & 0 \\
0 & -\frac{3}{2\epsilon_k} & 0 & 0 & -\frac{1}{4} & 0 & 0 & 0 & \frac{3}{2\epsilon_k} & 0 & 0 & -\frac{1}{4} & 0 & 0 \\
0 & 0 & 0 & 0 & -\frac{1}{2\epsilon_k} & 0 & 0 & 0 & 0 & 0 & 0 & \frac{1}{2\epsilon_k} & 0 & 0 \\
0 & \frac{2}{\epsilon_k^3} & 0 & 0 & \frac{1}{\epsilon_k^2} & 0 & 0 & 0 & -\frac{2}{\epsilon_k^3} & 0 & 0 & \frac{1}{\epsilon_k^2} & 0 & 0 \\
0 & 0 & \frac{1}{2} & 0 & 0 & \frac{\epsilon_k}{8} & 0 & 0 & 0 & \frac{1}{2} & 0 & 0 & -\frac{\epsilon_k}{8} & 0 \\
0 & 0 & -\frac{3}{2\epsilon_k} & 0 & 0 & -\frac{1}{4} & 0 & 0 & 0 & \frac{3}{2\epsilon_k} & 0 & 0 & -\frac{1}{4} & 0 \\
0 & 0 & 0 & 0 & 0 & -\frac{1}{2\epsilon_k} & 0 & 0 & 0 & 0 & 0 & 0 & \frac{1}{2\epsilon_k} & 0 \\
0 & 0 & \frac{2}{\epsilon_k^3} & 0 & 0 & \frac{1}{\epsilon_k^2} & 0 & 0 & 0 & -\frac{2}{\epsilon_k^3} & 0 & 0 & \frac{1}{\epsilon_k^2} & 0
\end{bmatrix}
$$

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